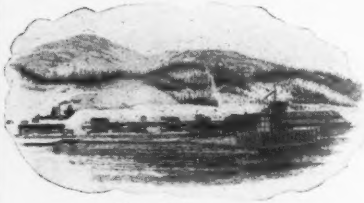
Compressed Air

A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR.

VOL. X. NEW YORK, JANUARY, 1906. No. 11.

The Slogan of the Cameron, "*CHARACTER: the Grandest Thing*"

Robt. A. Kinzie, Supt.



Office of

Alaska Treadwell Gold Mining Co.

File No. 46

Subject Inquiries.

Main Office
Mills Building
San Francisco, Cal.

Treadwell, Alaska, November 2, 1905.

A. S. Cameron Steam Pump Works,
Foot of East 23d Street,
New York City, U. S. A.

Dear Sirs:

With regard to your letter of October 19th, you perhaps know that we handle very little water and most of this comes from the shafts in the process of sinking, and from our open works.

At present we are using in the Treadwell mine, two No. 5 and two No. 7 Sinking Pumps and two No. 7 Station Pumps. At the Mexican mine we are using two No. 5 Sinking Pumps and at the Ready Bullion mine, two No. 5 Sinking Pumps and one No. 7 Station Pump, and at the 700 Foot mine, one No. 5 Sinking Pump.

All the above pumps are giving satisfaction in the places used. If we knew of any better pumps we would certainly get them.

Yours truly,

ALASKA TREADWELL GOLD MINING CO.

By Robt. A. Kinzie.
General Superintendent.

RAK/OES.

"Compressed Air,"

OR

THE COMPRESSED AIR MAGAZINE.

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR.

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VOL. X. JANUARY, 1906. NO. 11

Air Hammer Rock Drills.

We publish in this issue an interesting article entitled "Air Hammer Rock Drills in Mining" by Mr. Edward A. Rix. Mr. Rix is a veteran in the design, manufacture and use of mining machinery. As an expert in pneumatics, especially in connection with the practical application of compressed air to mines, no one stands any higher than he. He has designed some of the largest pneumatic plants which are now in successful operation and, as an author, he writes with a style so clear and so practical that it is a pleasure and profit to receive his communications.

In treating of air hammer rock drills Mr. Rix has touched upon a subject of active interest at the present time. The air hammer, or what is commonly called the pneumatic tool, when first invented was supposed to have its principal application in stone quarries and yards as a chipping and carving tool. It soon developed into a broader field—that of metal working in connection with chipping and riveting. To-day the boiler works, foundry and machine shop that does not use pneumatic tools is looked upon as almost a curiosity. The air hammer, having attracted so much attention in metal work, has now become an important adjunct in the mine and quarry. It is used in connection with the heavier rock drills more as an auxiliary and not as a machine suited for the deep hole work. Where large blocks of stone are dislodged through blasts from benches in quarries and stopes in mines the air hammer drill is used profitably for block-holing; that is, as a means by which shallow holes are put in for the insertion of powder to break up the blocks into smaller and more portable sizes. This is perhaps its chief work, but it also has many other fields of usefulness, such as cutting hitches, trimming, gadding and in all classes of work where shallow holes are wanted. Like the "puncher" in coal mines this machine met with considerable prejudice at first because of the complaint that it is hard on the runner. Improvements in construction and familiarity with its uses have overcome this objection, so that now the mine-worker and quarryman have no difficulty in securing competent runners who, with this little machine, are able to assist in reducing the cost of the product to a very marked extent.

Mr. Rix's paper is worthy of careful study in that he gives not only the history of the introduction of the air hammer drill, but its practical application and its advantages.

Air Hammer Rock Drills in Mining.*

It is evident from the way in which air hammer rock drills are invading the mining field, that they must be given a serious hearing. Because they weigh less than twenty pounds, and may be held in the hand during operation, is no reason why they are not entitled to due respect. When I first heard of them, I, in common with many others, did not consider they

* Read at the convention of the California Mine Association, held at Grass Valley, Cal., Nov. 21, 19[illegible]

were anything but the offshoot of the frenzied claims of pneumatic tool builders, who were trying to find an outlet for their over-productions.

A letter two years ago from some young men at the Black Oak Mine, who were selling the "Little Wonder" drill in that territory, led me to invite them to call on me at San Francisco and show me what they could do. This they did, and I learned a great deal about rock drilling in a very few minutes. I realized at once, that piston rock drills had a rival in the field.

Rock drill manufacturers have always known that a light weight drill would be a desirable adjunct to mining operations and machines have been built with cylinders having diameters as small as one inch and one-half. But they weighed seventy-five or eighty pounds, because they were all arranged for column mounting and all had rotating motions. It seemed to be accepted as gospel that in order to drill a hole of any depth, the hole had to be round, and in order for it to be round, the drill steel had to be rotated, and this rotating mechanism, really determined the character of the machine, increased its weight and forced it to be mounted. When I saw an eighteen inch hole neatly drilled in very hard granite and as round as possible, by a simple turn of the wrist, with a seventeen pound machine held in the hand, and with good speed, I saw that the pneumatic hammer had a mining life before it.

Three years ago, hearing that there was a wonderful drill at Denver, made by Schmucker, that used a hammer, I made a trip there, and inspected the machine, but found that it was so complicated and lightly made, that it would not suit general mining purposes. Much criticism also was made because it caused too much dust, and this same criticism has applied to the present hammer drills, but they have proven themselves so useful, that despite all the objections and dust or no dust, they are crowding to the front, and will not be denied. Although it is only about two years ago since these drills began to be put on the market seriously, there must be no less than 1,500 at work at the present time, throughout the country in mines and quarries and rock excavation work.

There are four of these machines upon the market to-day adapted for mining work, and naming them in order of their appearance upon the mining field, we have the "Wonder" drills, manufactured by the Hardsocg Wonder Drill Co., of Ottumwa, Iowa; the Shaw "Eclipse" air hammer drills, manufactured by the Shaw Pneumatic Tool Co., of Denver, Colo.; the "Little Jap" drill, manufactured by the Ingersoll-Rand Co., of New York; and the Murphy drill, manufactured by C. T. Carnahan Mfg. Co., of Denver, Colo.

It is always an interesting thing after a machine has proved a success, to know how it first came to be produced, and I have been at some pains to try and get this information, so that it might be of record at this early stage in the life of this very interesting rock drilling mechanism, but I find that the commercial atmosphere that environs the whole subject is very cloudy and it is somewhat hazardous to make a positive statement. It is a well known fact that short holes have been drilled in stone, with pneumatic tools, ever since a chisel was first put in them. This has led many to claim that they were the originators of this style of rock drilling, but we need not treat such claims seriously. From all I can learn, the real originators are Martin Hardsocg of Ottumwa, Iowa, and C. H. Shaw of Denver, Colo., who because of the rival business relations with each other, have rendered it difficult to determine which of these persons was the originator. It may be possible they arrived at their results simultaneously.

I have asked Mr. Hardsocg to give me his statement in the matter, and he writes me as follows:

"Yours of the 31st, in reference to who is the originator of the air hammer drill, has been referred to me for answer. I believe that I am the first man that ever made the air hammer drill a success, and that I am the originator of the idea of using it for drilling holes over 6 inches deep. I found out that pneumatic hammers were being used for drilling plug and feather holes in rock. The turning of the bit was done with a wrench and the dust was blown out by a small hose attached to drill and direct air through the hose served to blow out the cuttings while the tool was in operation.

"The idea occurred to me that if a hole were made through the bit so the air could pass through, the same would serve the purpose much more satisfactorily, as

the hose could not blow out the dust over 6 inches deep from the top of the hole and it therefore would not answer for drilling holes from one foot to five feet deep. At that time, I was not aware that Leyner was making a large drilling machine with hollow bits and using water for the purpose of getting the cuttings out of the hole being drilled.

"I also claim to be the originator of making a bit with more than four corners. This was designed for the purpose of making it less difficult to drill a round hole with so rapid a striking tool as the pneumatic hammer, and to avoid turning the drill by a wrench, I simply turned the bit with the hammer, which made it far more convenient.

"In place of making a turning device for turning the bit, as is commonly used on most all power drills, I simply turn the hammer, bit and all together, doing the turning at the same time, that the drill is fed into the rock.

"The air feed was invented by our foreman, C. J. Smith. At the beginning, I bought the hammers from different pneumatic hammer manufacturers, and the last I had made was by Mr. Shaw, of Denver, Colo., by inducing him to alter his hammer for my special purpose, and I soon after manufactured them myself, and I also made further improvements in the construction of the hammer, forging the whole hammer handle and all out of one piece and putting on a rubber flexible handle to avoid vibration to a man's arm."

Mr. Shaw claims that prior to the time spoken of Mr. Hardsocg, he had a hammer drill in operation at the Elkton mine at Cripple Creek, Colo. So that these statements must constitute as far as I am concerned, the history of the beginning of these machines.

In construction, all of the drills have about the same weight and exterior appearance, and they are all alike mechanically, except the "Little Jap" which has a valve-actuating mechanism, while the others are valveless hammers, or vibrators, having a piston which is its own valve and which is the only moving piece in the whole mechanism.

These valveless machines are very economical in the use of air, because the live air at full pressure acting upon a small area of the piston or hammer which causes the backward stroke, is after the backward stroke is performed, again used expansively at a lower pressure upon the whole area of the piston, to give the forward stroke. The piston has a diameter of 1⅝ inches and an approximate width of 1⅞ inches, and makes about 2,000 blows per minute. The end of the piston is hardened and impinges directly upon the end of the drill steel which is held loosely in the chuck and by reason of its being hexagon, the steel may be rotated slightly back and forth as the hammer is twisted by the hand.

All of these hand drills weigh about seventeen pounds, and consume, let us say for safety, 25 cubic feet of free air per minute, although claims are made for 17 cubic feet. They should be operated at about 80 to 90 pounds pressure per square inch.

It was early learned in the piston rock drill business that while a short stroke did good work in drilling, it was useless because it would not throw the drill dust and cuttings, or the mud out of the hole, and the drill bit would soon become clogged and useless.

Leyner overcame this by using a hollow steel and forcing water through the steel to the drill point, thus not only keeping the cutting point clean and giving it great advantage, for rapid drilling, but the water kept the drill point cool and preserved its temper, thus making it do more work. The hammer drill manufacturers used air in the same manner that Leyner used the water, and used the same hollow steel but they raised a large amount of dust, which at first, threatened to drive the machines out of the mines, but objections to this are growing fainter and fainter and like the objections to the headache-producing fumes of giant powder will soon be heard of no more.

This does not mean that the manufacturers are not trying to remedy this evil, for they are trying their best. The Murphy people provide a sponge which may be readily fastened around the drill steel, and being saturated with water is used like the old time mop in hand drilling, and indeed a regular old time mop can also be used effectively or water thrown in from a can, or small hose will also kill the dust.

The Little Wonder Company provide a very simple attachment for the end of the drill so that water may be discharged through the hollow drill and if a water supply from pipes or hose is not available

a small container, holding 10 gallons of water, is supplied and connected to the air pressure, so that the water is forced from the container through the drill bit.

All of these various devices, however, mean attention, thought and care on the part of the miner, and the general result is that he leaves them all out and endures the dust; and right here, it might not be amiss to suggest that the simplest solution of this dust problem would be a practical, inexpensive head or face gearing of some kind, to be worn by the miner, and whoever will perfect such a device will find a ready market for it, because these hammer drills have come to stay and conditions will have to be met, so they can be thoroughly acceptable.

At first, the drill steel was simply a tip about six inches long, welded to stay-bolt iron which, as you know, has a small hole throughout its length. This was done because drilling the steel was very expensive; in consequence, the drill was round, about ⅞ inch in diameter. There proved to be objections to the round shape, hexagon being preferred, and the welds were always breaking so that at present the proper drill is the all-steel hexagon shape and means have been found to render them not too expensive. Some find that solid hexagon bits will do their work well enough and by using water freely and spooning or gunning the hole frequently, that satisfactory work is done, but this is for the most part in the softer rocks or in sinking, where there is sufficient surface water to keep the hole flooded, or in the uppers where the dust will gravitate away. Nine-tenths of the machines, however, exhaust the air through the steel to clean the hole. The first bits were made with parallel ridges like a stone mason's dressing hammer, and files were used to sharpen them. Then these ridges were made radial and shallow, and still sharpened with a file; but these methods all were soon abandoned for a radial toothed bit, that can readily be sharpened with the proper dolleys. Six teeth seem to be the favorite number. It is evident that the less the teeth the greater the angle of rotation for the machine, in order to make a round hole; but, inasmuch as it is easier to operate the drill the smaller the angle of rotation, there quickly developed bits with many teeth. But here, again, it was found that the greater the number of teeth the smaller they had to be, and the harder they were to sharpen, and thus gradually was developed the six-tooth bit as a compromise between all the advantages and disadvantages of the question. One of the manufacturers of these hammers has developed a machine for sharpening these drills, which is very convenient and will naturally save much time and expense where a number of drills are at work.

The hose used is one-half inch pneumatic hose, with plain couplings or lightning couplings, as may be desired.

At first these machines were used with a valve or trigger that had to be held open by the hand or held open by pressure; but it tires the operator, and it is generally conceded now that a plain shut-off valve, similar to those used on standard mining drills, is preferable.

The first objectionable impression created upon seeing these hammer drills in operation is that the vibration and jarring would soon put the operator out of commission or the drill out of the mine. But such is not the case. There is no more vibration than there is at the feed-screw handle of a standard mining drill, or than is encountered in the many thousands of pneumatic hammers used in industrial work. Of the two, I imagine the mining hammer is preferable to a caulking or riveting hammer, for it does not irritate the ear.

To overcome, however, this objection, and at the same time to provide a convenient means of holding the drill for uppers or for holes beyond the ordinary reach, the pneumatic feed has been invented, and which, I understand, is the occasion of the first infringement battle to be soon fought over the patent rights of these drills and their appurtenances.

This pneumatic feed is simplicity itself, and consists in fastening the hammer to a small piston rod, which has a motion of from one to three feet in a small pipe cylinder. The compressed air behind the piston rod keeps the drill forced against the rock steadily, and automatically follows the progress of the drilling. It also absorbs all of the vibration. In most instances it requires a mounting, and this is done with a small column, arm and clamp, the same as a piston drill. These appurtenances, however, are so light and small, compared to those used for piston drills, that

they may be set up in one-third the time.

What I have heretofore said applies in general to the light hand machine, which I consider to be the one most generally applicable to successful results in mining. The success, however, of the hand drill has led the manufacturers a step further, and they have produced a slightly heavier machine, which is mounted on a column, arm and clamp, and which is calculated to dispute the ground with the standard baby drills of the regular type, and, inasmuch as it has by no means yet been proven that they offer advantages over the standard baby drills, we will in this paper let this part of the subject alone and confine ourselves to the field where they are paramount.

The advantages of the hammer drills appear to be that—

First—They are extremely simple, having, in general, but one moving piece.

Second—They require little or no repair, if properly oiled, thus saving much time and expense.

Third—Requiring but a moment to change bits, clean a hole or to begin a new hole, at least nine-tenths of the labor paid for is for drilling, while in the piston drills the actual drilling does not occupy more than two-thirds of the time, and probably not over one-half.

Fourth—The destruction of drill steel and breaking and dulling of bits for the same footage of holes is not over one-half that caused by the standard drills.

Fifth—It is economical in power, each machine requiring one-half the air consumed by the smallest standard piston drill.

Sixth—It can be used in extremely close quarters, where it is impossible to use a piston drill, or to even swing a hammer.

Seventh—It does not require any special skill to operate it. In half a day's time an unskilled laborer will find himself perfectly at home with the machine, and will be doing satisfactory work. And herein lies one of the great values of this machine. It takes a miner to use a hand drill or run a piston drill, particularly the latter, for only experience can overcome the difficulties of seamy ground, filchered holes, starting a hole, setting up a column, and determining the speed, pressure and stroke for a piston drill. It is now possible for a layman to do a little prospecting with unskilled labor, as far as removing rock is concerned, and the menace of combinations of skilled labor cannot be as effective as it might otherwise be.

Eighth—In rock suitable for the operation of these hammer drills, the investment for drills and machinery and the power required is about one-half that required for the standard drills, thus giving many prospectors of limited means an opportunity to install a power-drilling plant, which will save them time and energy in determining whether they have a mine or not.

In averaging the claims made by the manufacturers of these four air-hammer drills, we find that they claim, in average granite or quartz, an inch and a quarter hole can be drilled at the rate of three to four inches per minute, and in hard sandstone or limestone, or similar rock, from seven to ten inches per minute. These statements are misleading, for the speed of drilling diminishes with the depth drilled, for a very good mechanical reason, independent of any difficulties that a deep hole may of itself offer. This reason is because the longer the drill bit the heavier it is, and consequently the more power it takes to overcome its inertia, and the less effect the blow will have. There is, then, a limit to the depth which these machines will drill economically. Just what it is, I do not know, but it may be about four feet. The standard rock drills are not subject to this limitation.

In studying over the various commendatory letters received by the various manufacturers of these air hammer drills regarding the work done by their machines, we may sum them up as follows:

They all agree that one hammer drill will do the work of from six to ten single hand drillers, depending upon the rock.

In hard limestone, 50 feet in eight hours, and in softer limestone, 75 feet in eight hours.

In hard quartzite, 60 to 80 feet in eight hours.

In heavy sulphide ore, 3 feet in ten minutes.

In hard granite shaft, 30 to 60 feet in eight-hour shift.

In ordinary hard rock, 100 feet in eight hours.

In porphyry, 4-foot hole in thirty minutes.

In hard ore, 36 feet in four hours and five minutes, being 23 minutes less than a 3⅛-inch piston drill, and with one man against two.

In shaft sinking, used one-half the power for the same work as the piston drill, and did more work and averaged six single hand drillers.

In an English granite quarry, at a test of four hammer drills, the best machine did one foot in nine minutes and the next machine one foot in fourteen minutes.

In slate foot wall, one foot in two minutes.

We must therefore conclude that in the average rock we encounter in mining work, and where an inch to an inch and one-eighth hole, three or four feet deep, will carry power enough to do the work, they are equal, and perhaps superior, to piston rock drills.

That in extremely hard rock they are superior to hand labor by at least four or five to one, but inferior to piston rock drills.

That for large or deep holes they are not suitable.

For cutting hitches, for block holes, for trimming and for use in very small stopes, they have no rival at all in the other machines.

The use of these hammer drills does not seem to interfere with the use of the piston rock drills, but rather to supplement them and to extend the field of pneumatic drilling.

A complete outfit, consisting of a belt-driven compressor, an air receiver, one hammer drill, with hose, dolleys and drill bits, can be purchased for about $400, and a similar steam-driven outfit for $500, not including any motive power, and this price makes it possible for a prospector or a small mine to take advantage of power drilling.

The power required will be five or six horse-power.

A similar standard baby piston drill outfit will cost about $700 and $800, respectively, a price which, in many instances, proves a serious consideration, especially as from ten to twelve horse-power is required to do the work.

In all ordinary prospecting work, the drilling of the rock causes the principal loss of time and money, and an extended time, with the changes it brings in the interest or financial ability of the prospecting parties, militates materially against a mining venture.

It is good judgment, therefore, to get as much work done as possible, with the least time and expense, and it must be left to your judgment, after the splendid showing already made by these air hammer drills, if you can afford to use hand drills, where these machines can do at least five times the work with the same expenditure of money; and, particularly, as any of these machines may be had for a week's trial at simply the cost of transportation.

Many large mines have found it to their advantage to use these machines in quantities up to one hundred in number, and the following list of well-known mines is in some measure a guarantee for these hammer drills:

The Homestake
The Calumet & Arizona
The United Verde
The Cananea Consolidated
The Utica
The Waldorf Co.
The Finlay Consolidated
The Boston & Montana
The Copper Queen
The Sheepranch Mine
The Austin Group
The Fremont Consolidated
The Etna King Co.
The Oro Fino
The Gwin
The Argonaut
The Kennedy
The Lightner
The Dutch
The App
The Eagle-Shawmut
The River Hill Co., etc.

After I promised to read this paper, I cast about for some good evidence which, in our own mining territory, would be pertinent and interesting, and requested Mr. C. L. Feusier, who operates the Sheepranch group of mines, to give us some data on the subject, informing him at the same time that it was for this meeting. You all know that the Sheepranch Mine is a deep mine of the average hard rock order, and a typical mother lode proposition. Another reason for asking Mr. Feusier to give us his experience lay in the fact that he is sinking a shaft 5 feet by 16 feet, and using but two hammer drills, weighing a total of 34 pounds to do it. And it seems, at first glance,

that it is a hopeless task. Under date of November 13th, he writes as follows:

"We have two hammers, and use the same in shaft sinking. Have been in use three months. The total number of eight-hour shifts is 161, two men to a shift. Total number of feet drilled, 1,938, an average of 12 feet to the shift. This sounds very bad, but the 161 shifts included all mucking, timbering, hoisting, and running the muck 1,000 feet.

"The above work represented the equivalent of one man working 322 shifts of 8 hours each. The depth of shaft with the above work was 81 feet. Drills dulled in 1,930 feet were 2,620. Size of shaft, 5 feet by 16 feet. Average air pressure, 70 pounds.

"The hammers are apparently doing as good work to-day as when they started. The cost of repairs for 1,938 feet of drilling is nothing. The machines have been in the repair shop since starting(12 minutes), and the cost of lubricants to date is $1.40.

"The character of the formation varies in hardness. Under a test in medium black slate, we drilled 4 feet 2 inches in 15 minutes, with 80 pounds air pressure. In the hardest ground I have encountered in this shaft (this ground would be termed hard anywhere, but not vary hard) it takes two men 8 hours to drill a round of 14 holes, 3½ to 4 feet deep, to load and to shoot.

"This is not under a test for one hole, but under actual working conditions, with an average pressure of 70 pounds.

"The hammers should have upwards of 90 pounds pressure. They do not get a fair deal with 70 pounds.

"The air exhausting through the steel will not blow the drillings out of the hole all of the time. The drillings collect somewhat after the hole is a foot and a half deep, and we use a gun to draw these drillings out. I am under the impression this difficulty would be very much removed if we could use a pressure of 90 pounds. As the pressure decreases, the bother with the pulp increases.

"These hammer drills need plenty of sharp steel. The steel sharpening is a very considerable item, for it takes longer to properly sharpen a hammer drill bit than it does a 3⅛-inch burleigh bit. The bits must be in proper shape, otherwise they will refuse to do good work.

"I have heard these hammers condemned, and I have seen the shape the bits were made, and I do not wonder the hammers did unsatisfactory work. To be sharp and properly tempered is by no means all. The wearing surface of the bit must be small, otherwise the turning of the drill is materially hampered, and the pulp cannot get away from the bottom of the hole. This is important—very important. It is the most important item I have noticed, and has more to do with the drilling capacity than the hard or soft ground.

"From a very strict account for the past three months of power used, I place the saving at 40 per cent. over that used with 3⅛-inch piston machines. The advantage of being able to place a hole exactly where it is needed, and exactly where it will break to the best advantage, accounts for this saving of power.

"The size of this shaft is exactly size wanted. No unnecessary ground has been broken. I have never before been able to accomplish this result with the large machines.

"Any one can handle these drills who is endowed with common sense, and do good work after one day's experience. I obtained better results by breaking in men who had never handled a piston drill at all than with the old machine men. Give a man with proper intelligence good bits and high air pressure, and he will make headway for the management in a sink with medium and hard rock.

"My experience does not go to very hard rock. Possibly they would do as well in that proposition. Understand, I am only speaking of a sink with all down holes. I know nothing of flat holes or up holes.

"The jar on a man is nothing. The turning is simple and somewhat tiresome on the start, but the miner soon becomes used to it.

"I have had far better results with the hexagon steel than with the round. Made about one-half the headway with the round steel. The difference is in blowing out the pulp. There is a better discharge area with the hexagon bit than with the round. This is important—very important."

Under date of November 17th, Mr. F. F. Ames, Deputy United States Mineral Surveyor and superintendent of the Etna Kind Mine, at Angels Camp, writes me as follows:

"Yours of the 14th inst. at hand, and, replying thereto, will say that we have the hammer drill in very hard green stone, cross-cutting, and with the two drills we are making about 3 feet per shift of 10 hours. We blast twice on shift 7 to 9 holes, 3 to 3½ feet deep.

"We have tried the drill under water, and it seems to make a 3-foot hole in thirty minutes, in very hard rock, and seems to clear itself perfectly, though for this class of work we have not as yet given the machines anything like a working test. It is my judgment that the harder the rock the better work these drills will do, in comparison with that of machine drills. With these machines there need be very little loss of time. They go, and keep going, and I believe they are going to prove great money-savers in the matter of mine work."

EDWARD A. RIX.

To Protect the Health of Railway Travelers.*

The danger of infection in railway-cars is a subject which is commanding the keenest attention of railroad companies, as well as that of physicians and the general public. The possible results of the association of such great numbers of persons in confined areas where precautions are not taken to guard against the spread of disease are thoroughly well known. It is the aim of the writer of this article to direct attention to methods now employed by competently managed railway companies to offset, as far as possible, these dangers.

The methods employed seem practical and efficient, and the care with which they are pursued offers the traveling public clean and hygienic surroundings.

At Melrose, New York, about six miles from the Grand Central Station, there is a railway yard where sleeping-cars, day coaches, and chair-cars are treated to a thorough cleansing and sterilization. Not a nook nor a cranny of any car is overlooked in the process. Should a train conductor's report show that a car of his train has conveyed a person suffering with a contagious disease or other illness, or that a death has occurred therein from any cause, that car is not again occupied until it has been cleaned from end to end. When its destination is reached, it is promptly conveyed to special quarters, sealed, and treated for a period of four hours with formaldehyde gas. This is always done when emigrants have occupied the car.

When an ordinary train, consisting of day coaches, arrives at New York, it is taken as soon as possible to the cleaning-yard. The aisle carpets and all furnishings are removed, and the flooring thoroughly flushed and scrubbed with soap and water. Once every three months each coach is washed with soap and water from top to bottom. During the winter the interior is washed weekly. The removal of dust is effected by means of compressed air, this task being a weekly process. At the end of every car's journey, the lavatory with which it is equipped undergoes a thorough scrubbing with soap and boiling water, and is then treated with a solution of muriatic acid.

Exceeding care is exercised in cleaning glasses used for drinking water, also the tank containing it. Four times a year the car flooring and the seat legs are painted; and every twelve months the aisle carpets are removed, washed, and recolored. The same process is applied to leather seats and backs.

Within a short time after the arrival of a train of Pullman cars at the Grand Central Station it is run out to the Melrose yards, where the work of cleaning is admirably systematized. Provided a Pullman conductor has reported no death, either from contagious disease or other cause, and no contagious case has been transported, every car of the train is at once entered by a squad of cleaners, whose duty it is to remove all portable fittings of the car, such as the aisle carpet bottoms and backs of seats, the curtains, berth springs, mattresses, all linen, and blankets, hair-brushes, combs, and other minor articles.

The blankets are thrown over an especially constructed rack in the sunlight, where they are treated with compressed air, forcing from them, at very high pressure, all particles of dust, and restoring the blanket to its original freshness. If, during the removal of the blankets from the car, a soiled one is observed, it is not used again until washed. The operator of the compressed-air jet passes evenly over every inch of the blankets, blowing

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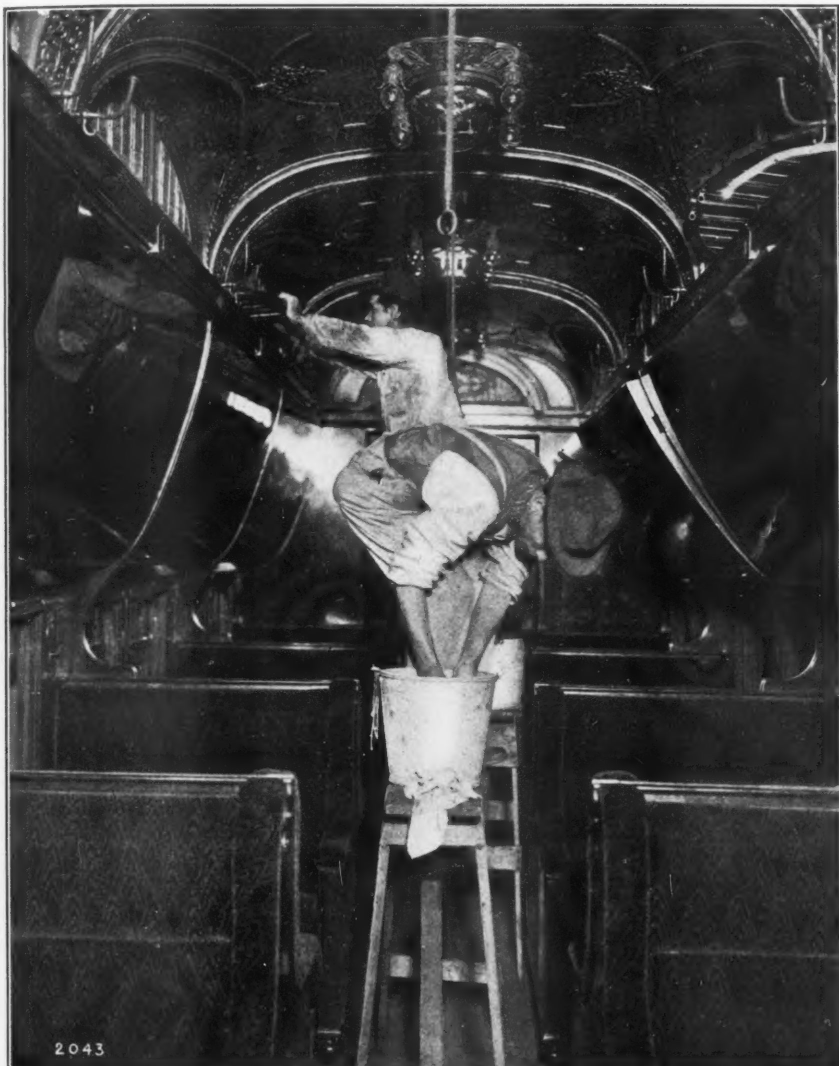


CLEANSING THE INTERIOR OF A CAR BY WASHING.

PREPARING A SLEEPING-CAR FOR DISINFECTION WITH FORMALDEHYDE GAS.

BLOWING THE DUST FROM EVERY NOOK AND CRANNY IN A CAR WITH A JET OF COMPRESSED AIR.

out the dust from each side. Afterward the blankets are hung for several hours in the open air.

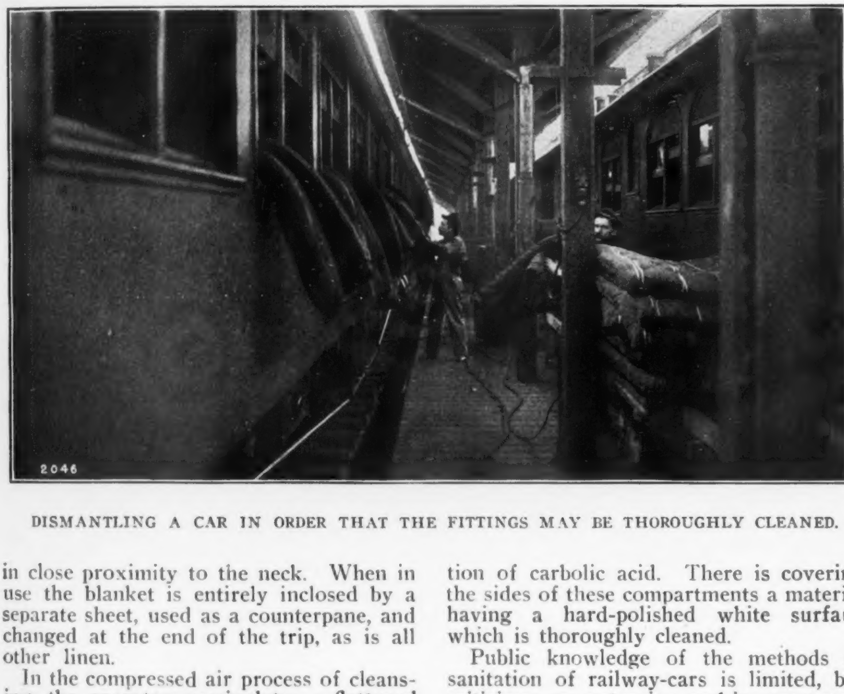
Blankets are washed as a routine duty every six months, and if a death has occurred in a berth a special fumigation and washing of the blankets used therein is ordered. The linen, consisting of sheets and pillow-slips, is collected and sent to a laundry, where it is actually boiled. The carpets, mattresses, and curtains also are blown out with compressed air.

There is now in use in sleeping-cars a clean sheet enveloping the blanket, so commonly complained of formerly when in close proximity to the neck. When in use the blanket is entirely inclosed by a separate sheet, used as a counterpane, and changed at the end of the trip, as is all other linen.

In the compressed air process of cleansing, the operator manipulates a flattened metal nozzle, triangular in shape. The air, at 100-pounds pressure, is forced through a slotlike opening nine inches in length. After the removal of all the interior fixtures, the compressed air, which is conveyed by a system of pipes along an especially constructed platform, is transmitted to different localities by means of a long hose coupled to the supply-pipe. The operator, passing through the car, dislodges dust and refuse from every angle and crevice, from floor to ceiling. After him comes a detail of men to scrub the floors, which, in the newer cars, is of a cementlike character.

Special men are directed to polish all wood surfaces with a prepared oil, and windows are cleaned inside and out. The exterior of the car receives an extensive oiling.

The toilet compartments and plumbing of the new cars are of the most approved kind, and at the end of each trip the fixtures are scrubbed with soap and boiling water, and afterward treated with a solution of carbolic acid. There is covering the sides of these compartments a material having a hard-polished white surface, which is thoroughly cleaned.



DISMANTLING A CAR IN ORDER THAT THE FITTINGS MAY BE THOROUGHLY CLEANED.

Public knowledge of the methods of sanitation of railway-cars is limited, but criticisms are extensive, and in some cases well directed.

It is amazingly strange to observe the procedure of the traveling public. It is not an uncommon thing to see a passenger brush his teeth in the drinking-glass, or expectorate in the washing-bowl. These are examples of the distressing obstacles the railway companies have to combat, and the officials whose duty it is to enforce the laws of cleanliness should receive the

CLEANING BLANKETS WITH AIR JET PREPARATORY TO WASHING AND AIRING.

REMOVING DUST FROM MATTRESSES AND OTHER BEDDING WITH COMPRESSED AIR.

highest commendation for their efforts to give the public surroundings even cleaner than their own homes, not even excepting hotels, which are so commonly accepted by the public as clean. The department of sanitation of these companies is as important a feature as any other department.

Since the establishment, by different departments of health throughout the country, of the rule forbidding and penalizing expectoration in certain places, wonderful results have been accomplished. The people are learning the dangers of such carelessness and impropriety. This education has influenced the traveling public to a large extent, but the habit is still in evidence. Let us not criticise the managers of our railways so much, but turn our attention to the offenders, whose wilful, uncivilized practices tend so strongly toward the development of pulmonary diseases throughout our land.

The extent of tubercular infection in railway-cars has not before been mentioned here, but in the category of rules for trainmen precautions have not been forgotten for the travelers' protection when infected subjects are thought to be traveling. It has been suggested by the writer that certain cars be provided for such persons. The obstacles, however, are many in considering an arrangement of this kind. One may feel sensitive regarding the knowledge others may acquire of his affliction, if he be publicly set apart from his fellows. Again, different classes of people must enjoy certain privacy, and it is difficult to furnish such accommodations; for one such compartment should be no better as to sanitary facilities than the other.

In view of the enormous death-rate each year as the result of tuberculosis among all classes throughout this country and abroad, it is of great importance that each traveler should consider his associates, and guard, for the common protection, against the spread of disease.

Pumping Machinery for Acid Mine Water.

The severe conditions of modern deep mining often necessitate the use of special mining machinery, as the success or failure of the undertaking compels the engineers and mine owners to be exact and sure in the selection of the pumping machinery to be installed. The selection of a large pumping plant is always a matter of vital importance, and requires a thorough knowledge of the situation and appreciation of the surrounding conditions.

In the anthracite and bituminous coal fields, and also in the Montana copper territory, the water to be pumped from the mines is usually highly impregnated with sulphuric and other acids, which are destructive to unprotected parts of machinery coming in contact with them. The water ends of the pumps must, therefore, be designed to withstand not only the heavy pressures, as the lifts are often very high, but also the corrosive action of the water, to insure a satisfactory duration of service.

Hence, there are no factors so valuable to the pump designer and builder as a thorough knowledge of the requirements, and successful experience in meeting them through superior design and manufacture. When pumps are to be installed down in the mines, they should be so sectionalized, and with parts relatively light, that any or all can be removed or replaced at minimum cost and time. They should also be simple in design, having few working parts, and none exposed to external damage, yet accessible and easy to operate, so that comparatively inexperienced men can run them, should necessity arise. Further, these pumps should be compact, on account of the comparatively small area of mine shafts. In addition to the requisites already mentioned, it is essential that the pump be of perfect construction and reliable in service, from the fact that often, in an emergency, a pump may be submerged until it unwaters the mine, or run continuously for months without stopping, to prevent the mine from becoming flooded.

Figure I shows the Cameron simplex, outside packed, plunger pump, with pot valve water end and compound steam cylinder, in which both the high and low pressure cylinders are of the Cameron type, and have all the characteristics peculiar to the Cameron. Their steam or air mechanism consists of fewer working parts than any other steam pumps made, and is without any outside valve gear. It is positive in action, requiring no more skill to run them than a simple pump, from the fact that it is without intervention of arms or levers, and being equally efficient with compressed air as with steam for the motive power.

Figure II defines very clearly the construction of these cylinders, both being of hard, close-grained iron, and of ample thickness to allow re-boring if necessary. The ports are of such size and arrangement as to allow the pumps to be operated at very high speed, with the least friction and back pressure. The connections between the steam and the water ends are made by means of steel tie rods, two on each side; these are bolted to the lugs on the sides of the cylinders, and so arranged as to allow the low-pressure cylinder heads to be removed at any time; this gives accessibility to the low-pressure piston, as well as enabling the removal of the plunger, when necessary, without dismantling the pump.

The water end consists of two working barrels and four valve chambers, the latter being commonly called "pots." There are two water plungers connected to the outside rods, and they are the only moving parts in the water end, except the valves, coming in contact with the water.

The plunger works through deep stuffing boxes, which are lined with acid-resisting bronze bushings, that can be easily removed and renewed when necessary.

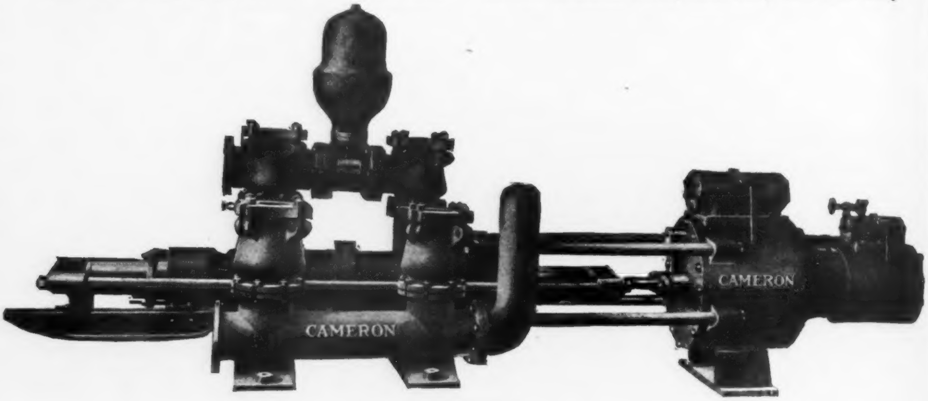


FIGURE I.

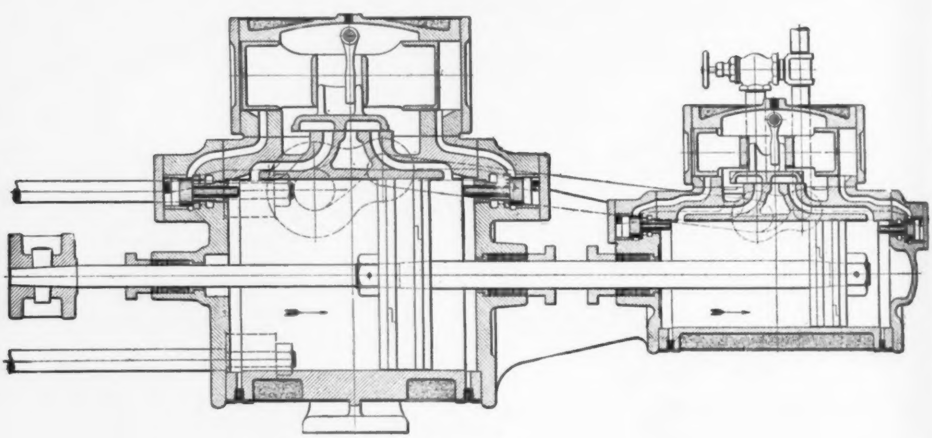


FIGURE II.

The interior arrangement of the valves or chambers is shown by the sectional view, Figure III. The valve chamber, No. 1, and cover No. 2, are cast of a special mixture of hard, close-grained iron. These chambers contain separate water valves, which consist of the several parts hereafter described. Valve seat No. 3 is an acid-resisting bronze casting, securely held in place. The valve No. 4 is a rubber disc, and is protected by the heavy bronze guard No. 5, which also serves as a stem, working in the guide placed when necessary at minimum cost. The velocity of the passage of water through the valves and chambers is reduced to as low a rate as possible by ample valve area and large water passages.

It is often essential to build this pump as a twin, consisting of two independent pumps, connected together by means of Y pieces, ells, gate valves, etc., so that they may be run together or separately when desired.

H. H. KRESS.

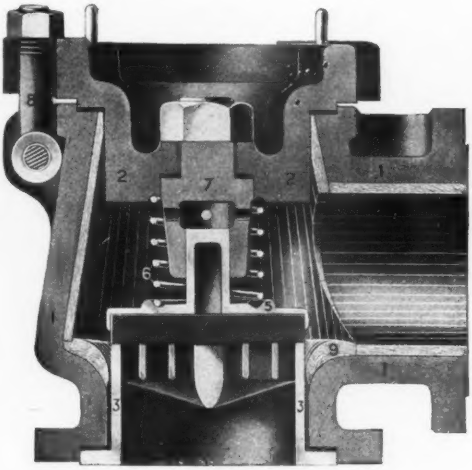


FIGURE III.

No. 7. A section of the spring is also shown as No. 6. The use of a large single water valve in each of these chambers, instead of groups of smaller valves, allows the passage of comparatively large solid bodies, such as pieces of coal and dirt, which may enter with the water, and would otherwise clog the valves. Each of the chambers is fitted with a cover, held in place by four swing bolts.

A distinctive feature of these water cylinders is that the metal throughout is of extra thickness, and, in addition, when ordered and necessary to resist corrosion, wood-lined with sound white pine (see No. 9), which is securely wedged in place, to be water-tight. All the water passages can be provided with either wood, bronze or lead linings, to meet the varied requirements, and these linings can be re-

Portable Air Compressors for the Panama Canal.

The Panama Canal Commission recently placed an order with the Rand Drill Company, of New York, for two portable air compressors, which embody some features of distinct novelty. These machines are intended to operate pneumatic tools in general repair work in the Canal service. It is also expected that they will be found of great assistance in erecting the heavy machinery which of necessity will be delivered in sections along the line of work.

The illustrations give a very good idea of the arrangement of these compact little plants. The prime mover is a 16 horsepower gasoline engine. It is mounted on

two steel channels, which constitute the frame of the truck. The engine shaft has at one end a heavy fly-wheel, 4 feet 8 inches in diameter; at the other end is a driving gear fitted with a friction clutch. Below and at one side of the engine, a small Rand single-stage air compressor is mounted, fitted with the usual mechanical intake and automatic discharge air valves, familiar to all acquainted with the machines of this manufacturer. The crank gear of the compressor meshes

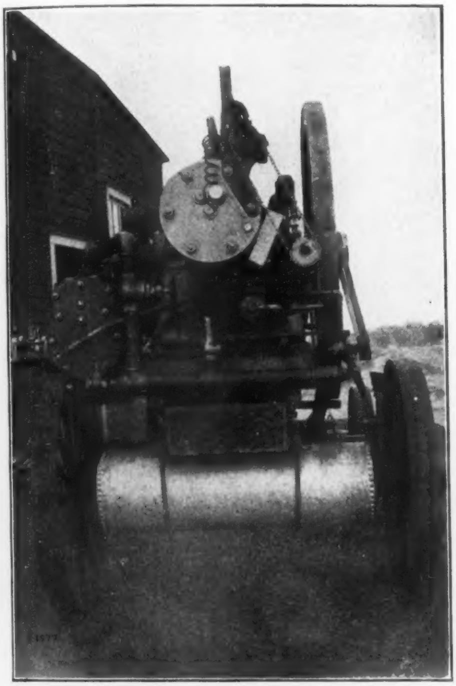
A novel feature of this equipment is the method of cooling circulating water for the engine and compressor cylinders. While provision is made for connection with an outside source of water wherever available, it has also been arranged for the machine to carry its own water supply. A rectangular open tank, holding about 100 gallons of water, is mounted on the truck in front of the engine. A small pump driven from the engine shaft draws water from this tank and circulates it

PORTABLE AIR COMPRESSOR.

directly with the driving gear of the engine, and a valve rod operates the air valve gear by means of a back crank. The engine is, of course, started unloaded, with the friction clutch free. When full speed is attained, the clutch is thrown in and the load on the air compressor assumed. Gearing is such as to give the compressor a speed of 150 revolutions per minute, at which the displacement of the compressing cylinder is 60 cubic feet of free air per minute, which is delivered at a pressure of 100 pounds.

through the cylinders of the engine and compressor. This water, heated by contact with the cylinder walls, flows upward to a perforated pipe elevated above the supply tank. It is here discharged through a series of fine holes and flows downward over a sheet of burlap to the tank below, being cooled by evaporation by exposure in a thin sheet to the open air. An air receiver, 18 inches by 4 feet 6 inches, is suspended beneath the truck and between the axles. A gasoline tank, with a capacity of about 30 gallons, is hung from the

truck in the rear. The entire machine runs on steel wheels. The total weight of this compressor outfit is 8,500 pounds. It has a wheel base 7 feet long, with a tread of 5 feet.



PORTABLE AIR COMPRESSOR—END VIEW.

Among other items on the same order for these portable air compressor plants were 4 Imperial air hammers, 2 Imperial wood boring machines and 2 Imperial rotary drills, together with a full supply of repair parts and accessories, such as hose and couplings.

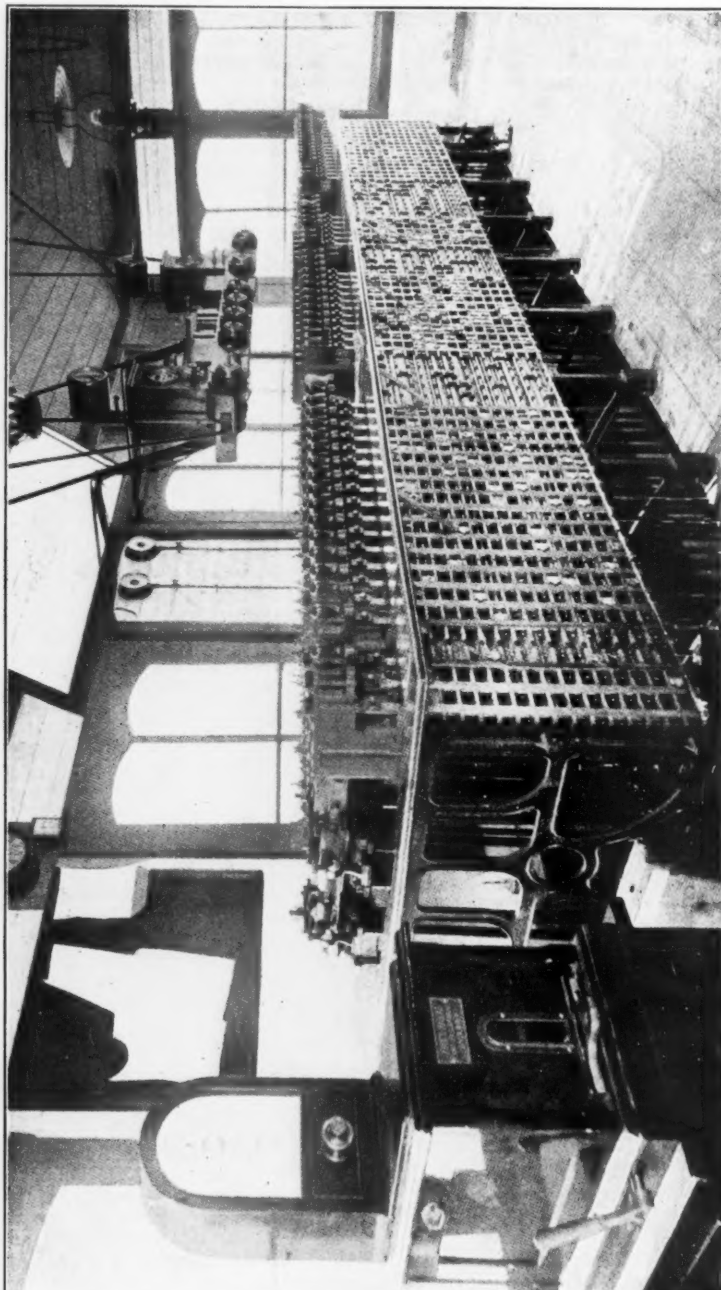
A British Railway Signal System.

LOW-PRESSURE PNEUMATIC ARRANGEMENT ADOPTED EXTENSIVELY ABROAD AND IN THE UNITED STATES.

In consequence of the large increase of traffic on English railways of late years, necessitating a greater number of tracks and considerable enlargements of stations and yards, there has arisen a distinct demand for some form of power-signaling which shall give greater ease and safety in handling heavy traffic, together with more economical working than can be obtained by the ordinary manual plants now in use.

In these days of high wages and increased general expenses, any saving in working and maintenance expenses has become of prime importance to railway companies, and the item of signalmen's wages and maintenance of plant is no inconsiderable one. The British Pneumatic Railway Signal Company claim for their system that with it one signalman can do the work of three with any manual plant, and this claim is based upon actual experience. Assuming a signalman's wages to be 30s per week, including clothes, etc., three men will cost £234 per annum, which, capitalized at 3½ per cent., is £6,700, the saving which can be effected by one man taking the place of three is sufficiently obvious. From this it will be seen that from a financial standpoint it is greatly to the advantage of railway companies to install power plants, even at an increased first cost over equivalent manual plants.

From the mechanical point of view the advantages are also very great. It is now agreed on all hands that rods and wires should be abolished or at least laid underground in station yards, on account of the great risk to railway officials from exposed gear, and the Board of Trade has recommended the abolition of rods and wires in busy yards in the latest act of Parliament dealing with railways. Besides this, train movements can be effected much more rapidly by means of a pneumatic system than by an ordinary manual plant, and the physical labor required of the signalman is practically a negligible quantity; also the automatic indication relieves him of considerable mental strain, so that not only can one man do the work of three, but he does it with less mental and physical effort, and consequently with less risk of being overcome by fatigue during long hours, an occurrence by no means infrequent under the present manual system. In the last two years many contracts for power signaling plants in Great Britain and the United States have been given for the pneumatic system.



LOW-PRESSURE PNEUMATIC INTERLOCKING MACHINE.

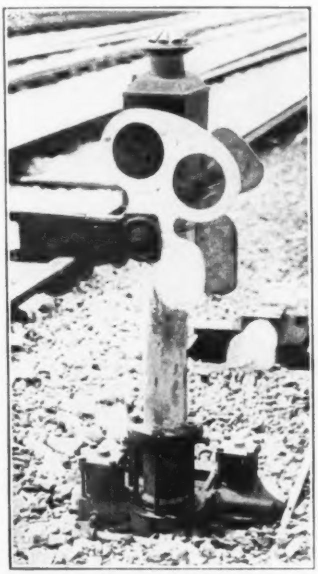
The apparatus for working railroad switches and signals has five characteristic features.

(a) It requires no force but air.

(b) The air pressure is always low; normally 15 pounds per square inch (1 kilogramme per square centimetre).

(c) Every movement is accomplished by air pressure; nothing depends on gravity or springs or withdrawal or reduction of pressure.

(d) Except when a switch or a signal is being moved, or an indication is being given, all operating and indicating pipes are subject to atmospheric pressure and no more.



DWARF SIGNAL.

(e) The final portion of the stroke of the "lever" is automatic, requiring no effort or care on the part of the operator. These points are more fully explained in the following text.

(f) Signal levers which are replaced by track circuit are automatic for the whole return stroke, and require no attention from the signalman for this portion of the operation.

The foregoing are mechanical advantages. There is also marked economy. The pneumatic machine costs little more to install than the mechanical, and less than the "all electric." Wear of movable parts is reduced to the lowest limit, and consequently the cost of maintenance and renewal is far below that of any other interlocking apparatus. The cost of inspection is less than with any other system, and one signalman in the cabin can care for as many trains as three or more men can attend to with mechanical levers.

The machine and devices described in this article, which are now in use on a large number of the prominent railroads in England and the United States, fulfill completely and economically the three chief functions of a railroad switch and signal device. These are (*a*) To furnish power to move the switches or points and the signals; (*b*) concentration in one cabin of the control of all the switches and signals within a given field, and (*c*) interlocking of the controlling parts of different switches and signals, so that it shall always be impossible to give conflicting signals. The power is compressed air at a pressure of 15 pounds per square inch above the atmosphere. The concentration is accomplished under ideal conditions, all connections from the cabin to the switches and signals being buried in the ground, and the action being so quick that any necessary or desirable distance can be covered.

The interlocking is based on the well-established mechanical types, but with all parts of much smaller size, though still amply sufficient to afford all necessary strength.

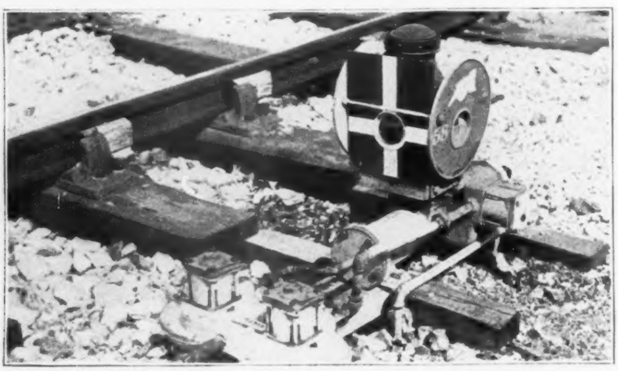
The minor as well as the main functions of interlocking signals are also fully provided for; and the advantages enumerated in the introductory paragraphs may be more fully stated as follows:

(a) A complete system of power movements and interlocking which requires no electrical apparatus.

(b) Low-pressure. The pressure used to move switches and signals is 15 pounds per square inch (1 kilogramme per square centimetre). This pressure is controlled by means of relay valves (hereinafter fully described), which themselves require air at but 7 pounds per square inch to operate. Low-pressure being made practicable, there is, with this system, no possibility of trouble from condensation of moisture in pipes; and annoyances from leaks, which are common with high pressure

apparatus, are practically abolished. A smaller quantity of air is used, and the service required of the compressor is, therefore, less than with high pressures. The action is quicker than with high pressure. Numerous tests of this system, confirmed by long experience in actual service, have proved that with 7 pounds pressure to the square inch, the time elapsing between the introduction of air into a pipe at a switch and the resulting valve movement at the other end of the pipe (in the cabin) is less than with high pressures. A switch 500 feet (152 metres) from the cabin is moved, and the return indication is received back at the cabin, all within a few seconds from the moment that the lever is pulled. The movement of a signal arm, at the same distance is practically simultaneous with the movement of the lever. Indeed, at the average distance, in any yard, the difference in the time required as between a switch or signal movement controlled by the electric current and one controlled by low-pressure air is so very small that it is practically impossible to measure it. A fifth advantage of this low-pressure system is the added flexibility of the power. With all the pistons designed to be moved by 15 pounds pressure, an abnormal requirement demanding, for example, 50 per cent. additional pressure, can be met by the desired increased compression, while still keeping within the very moderate limit of 22½ pounds per square inch (1½ kilogramme per square centimetre). A substantial advantage is the facility with which changes in piping can be made; joints can be separated and wooden plugs inserted in the ends while work is being done, and all without shutting off the compressor or main source of supply.

(c) Positive application of power is in every case required to accomplish any result. To move a switch either to or from its normal position, or to return to the cabin an "indication" that a switch has completed a movement, to move a signal to or from the all-clear or go-ahead position, or to indicate in the cabin that a signal has returned to the danger or stop position, air-pressure must be applied. A signal is held in the all-clear position by continued pressure of air in the pipe leading from the cabin to the signal. Absence or failure of power will always leave the signal in the stop or danger position, and thus be on the side of safety.



POT SIGNAL.

(d) All of the operating and indicating pipes are normally subject to atmospheric pressure only. Compressed air is introduced into these pipes only when a switch or a signal is being moved; so that there is practically no loss of air by leakage.

(e) The automatic indicating stroke of the lever, seemingly of minor importance, is found in practice to greatly facilitate the work of the operator or signalman. The original theory of pneumatic switch and signal movements was to divide the stroke of the "lever" (the valve handle, called "lever" on account of its function,

being the same as that of the lever in the older mechanical interlocking machines) into two parts, so as to provide for preliminary locking. The signalman moves the lever through the first part of its stroke; this sends air to the switch and the switch must complete its stroke and thereby send air-pressure back to a valve attached to a lever in the cabin, before the final part of the lever-stroke can be effected. The lever must not finish its stroke until the switch stroke is surely finished. The time which the operator must wait, after making the first half stroke before he can make the

SEMAPHORE SIGNAL.

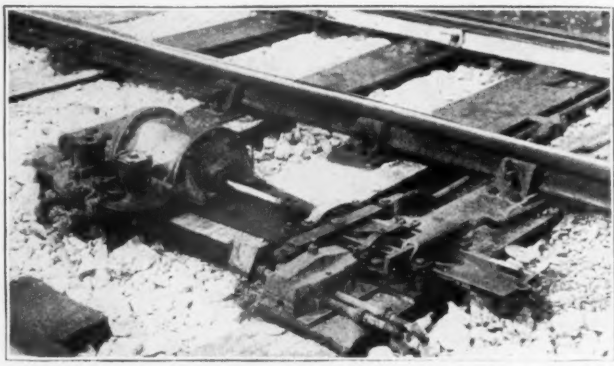
second half, is short, measured in seconds, but yet it is an appreciable addition to his necessary mental processes; for until he has fully performed his duty with one lever, he does not effectually turn his thought to the lever which is next to be moved. In this machine this waiting is rendered unnecessary; the air-pressure completes the lever-stroke without the man's intervention. The practical result of this is that the operator is relieved of the necessity of hurrying. Having moved lever No. 1, for changing a switch, his next act is to move lever No. 2 to give a signal for that switch; and with this device he is relieved of all thought of the switch as soon as he has made the half stroke with the lever, and he may then grasp lever No. 2 preparatory to moving it as soon as No. 1 shall have automatically completed its stroke. If, because of failure of any part, the completion of the stroke of lever No. 1 should not be effected, the operator would be warned of the fact by his inability to move No. 2, this being suitably interlocked with and controlled by lever No. 1.

Safety is the prime requisite in all interlocking. A second important element is the automatic "return indication" for each switch and signal movement, which was referred to in the preceding paragraph. Not only does this system indicate the correct movement of the signal or switch, but the indication air actually completes the stroke of the lever, thus relieving the signalman of all further responsibility. This is entirely lacking in manual-power, mechanical or any other form of power interlocking, the integrity of the rods, connections and cranks being the sole dependence in such machines for this assurance. In large yards there is a third element which tends to increase safety—the smaller force of men required in the tower or cabin. When from fifty to one hundred and fifty manual-power levers are worked in a single cabin it is found necessary to employ from four to eight men. This is necessary on account of the number of movements, the long distance from one end of the machine to the other, and the considerable physical energy required to move the levers. With the pneumatic machine the levers are nearly together, and the physical effort required to move them is too small to notice. With this saving in labor and in steps, it is found praticable to work a 150-lever cabin with two men. And not only do we need fewer men but the men have much easier work. They may be more deliberate in each movement, while, at the same time, they accomplish the desired result at the switch or the signal post with greater promptness. This moderation of the mental burden keeps the signalman's efficiency at a higher level.

The durability of the low-pressure pneumatic, as compared with the ordinary mechanical interlocking machine, shows to advantage. Experience for more than two years with the plant at the busy

passenger station yard of the New York Central and Hudson River Railroad in Buffalo, where the cost thus far for repair material has only been $3.85, warrants the assertion that the life of the plant will be at least double that of the ordinary mechanical apparatus under similar conditions. The wearing parts of the machine in the cabin have extremely light service. They are made interchangeable, are inexpensive, and of simple design, and new parts can be quickly substituted. In the pneumatic plant all the connections from the cabin to the switches and signals are immovable and are buried in the ground. In the mechanical plant, on the other hand, the carriers for supporting rods, the bell-cranks and temperature compensators are among the most expensive parts of the machinery to maintain.

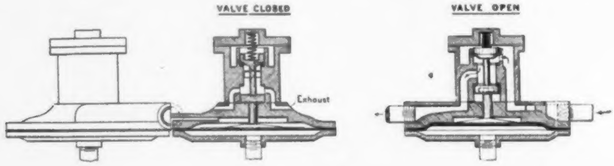
Economy of maintenance is the natural result of the smaller force of lever-men required and of the features of mechanical superiority just mentioned. Besides this the wages of repairmen is an item in which there is a large saving. The economy effected by the substitution of low-pressure pneumatic for mechanical machines at the Grand Central Station, New York City, affords a striking illustration of this point.



RELAY VALVES AND SWITCH CYLINDER.

The general exterior appearance of the interlocking machine, as well as of the signals, signal bridges and switch movements, is shown in the photographic views. We will describe the principal devices somewhat more in detail.

A chief characteristic of this system is the diaphragm valve. This valve is called the relay (and in diagrams shown is indicated by the letter *R*), because it performs a function analogous to that of the electromagnetic relay in electrical apparatus. It is actuated by a comparatively weak force (air at 7 pounds pressure per square inch), but by its action opens a valve which liberates air at 15 pounds per



THE DOUBLE DIAPHRAGM & VALVE

square inch (1 kilogramme per square centimetre), to perform any desired work. The construction of the valve is well shown in the illustration. The work to be done is to lift the stem of the vertically placed cylindrical valve in the upper part of the case; and this is accomplished by introducing pneumatic pressure on the under side of the horizontal rubber diaphragm in the lower part. This diaphragm is circular, 8 inches (2 decimetres) in diameter, and is quickly responsive to low-pressure. The pistons and openings are so proportioned that a movement of the diaphragm of only one-quarter of an inch (6.35 millimetres) is found sufficient for all purposes. Two relay valves, one at each end, control the switch cylinder, the piston of which moves the switch. Two at the foot of the semaphore signal post control the signal arm in a similar manner.

Other important parts are the main valve attached to the operating bar or "lever" of the interlocking machine, and the indicating valve placed at a switch or a signal, and actuated by the movement of the switch or the signal. This latter valve automatically notifies the signalman of the completion of the movement of the switch or signal.

Other parts which are essential, but which need no description, are: An air compressor, an air reservoir, air supply pipes to each switch and signal, cylinders 10 inches (2.54 decimetres) in diameter for switches and 5 inches (1.27 decimetres) in diameter for signals, and operating pipes ½ inch (13 millimetres) in diameter from the machine in the cabin to each switch or signal.

The drawing shows the pipes, cylinders and valves by which a switch is worked from the cabin, and the "indication" (showing that the switch has been moved) is returned to the cabin. The principal parts are: *S*, switch-rails; S^1, lock rod; *s*, switch rod; *M*, motion plate; *C*, switch cylinder; *D*, indicating valve; R^2, R^3, R^4, R^5, controlling valves; *L*, L^2, operating bar and slide valve; *I*, I^2, indicator cylinders; *H*, interlocking tappet.

To change the position of the switch the signalman grasps *L* by the handle and pulls it out. In doing this he admits air (from the main supply *X*, through the reducing valve *V*, thence through the valve L^2) through pipe *a* to valve R^3, which opens communication from the supply pipe *X* to the left-hand end of cylinder *C*, pushing the piston to the right. Observing now the slots in *L* and *M*, it will be noted that after about one-half of the stroke of L has been completed, it is stopped by the piston rod I^2; but the operation of valve R^3 already accomplished causes *M* to move through the whole of its stroke. This stroke of *M* is uninterrupted, but we must consider it in three parts. The first part, say one-third, does not move the switch, but valve *D* is moved far enough to close pipes *w* and *y*, while *u* and *v* are open to the atmosphere. At the same time lock rod S^1 has been liberated. As *M* moves through the next or middle portion of its stroke, it moves the switch; but it

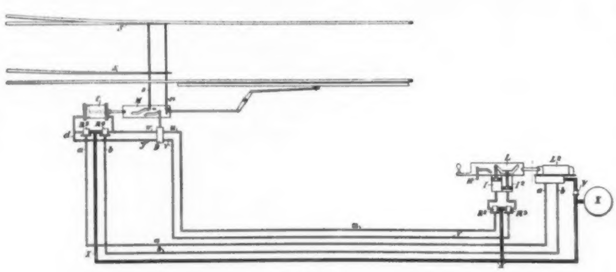
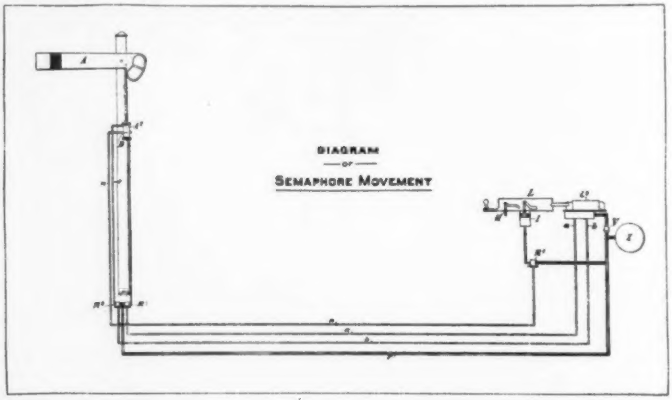


DIAGRAM
— OF —
SWITCH & LOCK MOVEMENT

now produces no effect on valve D, because the rod of D is now engaged by the straight portion of the slot in plate M. The switch being set, the third and final part of the stroke of M locks the switch by pushing a bolt, cast on to the motion plate M, through a hole in S^1; and also (but not until after the bolt has entered its hole), the plate changes valve D so as to connect together pipes v and y. This conveys pressure from the supply through R^6, d, D, and v to valve R^3, which valve then admits air from the supply to I^2, forcing the piston rod upward, and, by means of the diagonal portion of the slot in bar L, forcing this bar to complete its stroke, and this without any action on the part of the attendant.

as those for switch, but there is only one indicating pipe and one indicating cylinder. To assure the signalman that a signal is in the danger position, the same process is used as with a switch; but to assure him that a signal is in the alright position is deemed unnecessary, and the parts are omitted. The signal connections are shown on this page. The principal parts are: A, signal arm; A^2, signal cylinder; R^2 and R^3, diaphragm valves, controlling the admission of air to the top and bottom, respectively, of the signal cylinder; R^1, diaphragm valve controlling admission of air to cylinder I; L, L^2, operating bar and slide valve, controlling R^2 and R^3; H, interlocking tappet. The signal is in the normal or danger position.



By the action of L^2, pipe a is now opened to the atmosphere. Valve R^5 is now relieved from pressure, and R^4 is closed; so that the left-hand pipe to cylinder C and its connection to and through D are open to the atmosphere. All four operating pipes are now at atmospheric pressure.

By the movement of L, tappet H has been moved so as to produce the proper mechanical locking of conflicting levers as in ordinary interlocking machines.

To move the switch back to its original position, the opposite set of pipes is used. The bar L is pushed to the right, air through b actuates R^4, and the return indication to the cabin through u actuates R^2, and lifts the piston in I.

To work a signal, valves and operating pipes are used of the same general style

The indication port B is now open to maintain a connection between the upper part of the cylinder and the pipe N, but the instant the signal arm leaves the horizontal position, the piston shuts off this connection. To change the signal the signalman pulls L to the left, the whole length of its stroke. By this movement L^2 is moved, admitting air at 7 pounds per square inch from the supply X through the reducing valve V to pipe a, which actuates valve R^3, and supplies air at 15 pounds per square inch to the lower end of cylinder A^2, pushes up the piston, putting the signal in the inclined or all-clear position. In this position it remains as long as L is pulled to the left. To restore it to the normal or stop position, L is pushed to the right until it is stopped by the piston rod of I (at the end of the

horizontal part of the slot in L). With L in this position, pipe A is exhausted, pipe b charged and valve R^2 is opened, which admits air from the supply through pipe e to the upper end of A^1. This restores the signal to the horizontal position, and the piston discloses port B. Air now passes from e through B and n to R^1, and the latter causes air to enter I and complete the return stroke of L by the action of the piston rod on the diagonal part of the slot. Pipes b, e and n are now at atmospheric pressure, and the parts are in the same position as at the beginning.

It is possible and generally desirable from many points of view to operate two or more signals by one lever in the cabin. This is done when there are two or more roads leading off a single one, and in this case only one signal can be lowered for the particular route which it commands, therefore, which signal is lowered depends on the position of the points. By means (hereinafter described) of a valve connected to the rods actuating the switch it is possible by pulling one lever in the cabin to operate the particular signal corresponding to the route set up.

The diagram showing how this is accomplished is appended, and the following description will make the matter perfectly clear.

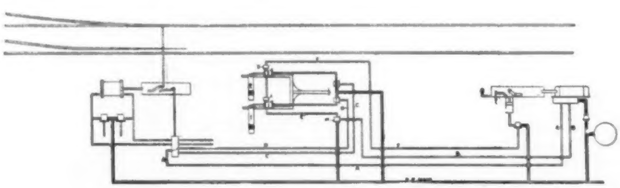
The indicator selector valve which is placed at the points and worked off the motion plate is similar to the ordinary switch indicator valve, with the exception that it is provided with extra ports, and in one position of the motion plate the low-pressure operating pipe A is connected by means of the extra ports in the indicator selector valve with a low-pressure pipe operating the diaphragm for signal No. 1, and when the points are moved over the pipe A will be connected to the low-pressure pipe operating the diaphragm for signal No. 2.

We will assume that the points in the position shown in the diagram will be controlled by signal No. 1, and the points reversed by signal No. 2.

On reversing the lever in the cabin the low-pressure air is admitted into pipe A; it travels through the indicator selector valve as shown by the dotted line to the diaphragm and valve No. 1, so admitting high-pressure air to the cylinder operating signal I; on the signalman putting his lever to the normal position pipe A is exhausted and low-pressure air admitted to pipe B to the diaphragm IA, so admitting high-pressure air to cylinder 1 and putting the signal to danger.

The signals having gone to danger, the same high-pressure air is free to go through the indication valve 1 and then through the cylinder 2 and indication valve 2 back to the cabin, which completes the stroke of the lever.

DIAGRAM OF SELECTED SIGNAL



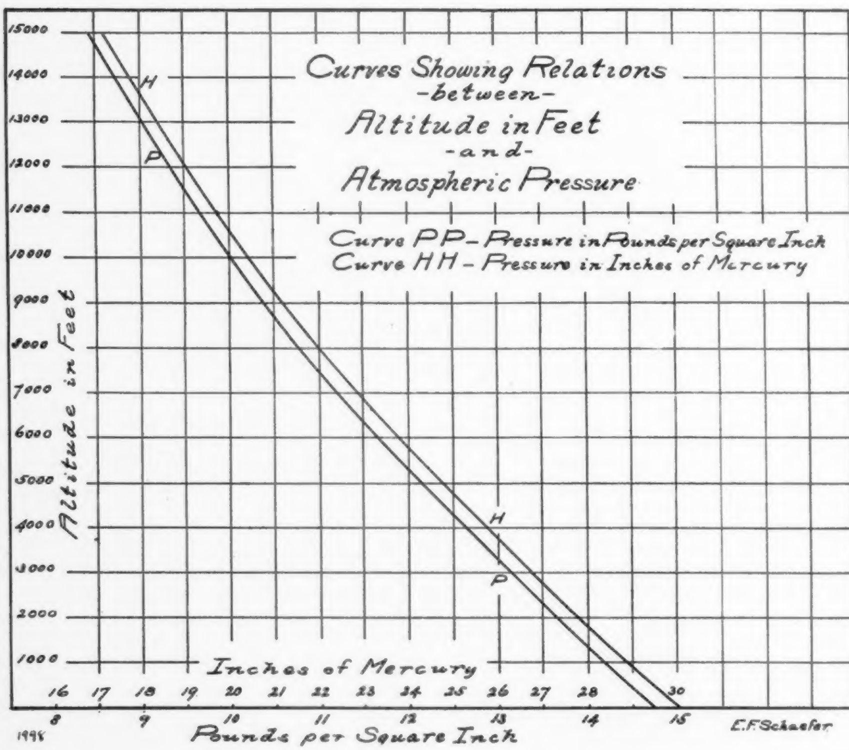
The object of making the indication pipe go through both the cylinders in series is to ensure that both the signals are at danger before getting the indication; this, of course, is obviously necessary, or the indication would be of no value. By the method of selecting two signals from a switch we save one signal lever in the cabin and its appliances, one low-pressure reverse pipe, one low-pressure normal pipe, and one high-pressure indication pipe. Instead of having two double diaphragms and valves, we have one double diaphragm and valves and one single diaphragm and valves; against this has to be put the three pipes running from the signal to the switch movement, which is generally a much shorter distance than from the cabin to the signal.

The advantages of using selected signals

are obvious, the following being the most noticeable. The number of levers is diminished, and the quantity of pipe required to operate two or more selected signals is very much less than that required to operate the same number of signals separately; in fact, throughout a saving of apparatus, and thereby expense, is achieved by adopting the use of selected signals.—*Engineering World.*

Altitude Atmospheric Pressure.

Atmospheric pressure at various altitudes occasions more or less doubt as to the proper figures to use in computations



where volume, efficiency and horse power considerations are involved.

A simple algebraic formula, covering all elevations and not even necessitating the knowledge of logarithms, is given in the following expression:

$$P = 14.75 - \frac{57000\,E - E^2}{100,000,000}$$

In this equation:

P=atmospheric pressure in pounds per square inch at any altitude.

E=altitude in feet.

This expression may be re-written to take the form:

$$E = 28500 - 10000\sqrt{P - 6.6275}$$

The pressure in inches of mercury is given by:

$$H = 2.037\left[14.75 - \frac{57000\,E - E^2}{100,000,000}\right]$$

H=inches of mercury or barometric pressure.

The appended table, giving the atmospheric pressure in pounds per square inch, and in inches of mercury was calculated using the above formulae. The table includes a range of altitudes from sea level to 15,000 feet.

The graphical expression of the equations is serviceable for determining at a glance the atmospheric pressures at altitudes not given in the table.

ALTITUDE TABLE

Altitude in Feet.	Pounds per Square Inch.	Inches of Mercury.
0	14.75	30.05
1,000	14.19	28.91
2,000	13.65	27.81
3,000	13.13	26.75
4,000	12.63	25.73
5,000	12.15	24.75
6,000	11.69	23.81
7,000	11.25	22.92
8,000	10.83	22.06
9,000	10.43	21.25
10,000	10.05	20.47
11,000	9.69	19.74
12,000	9.35	19.05
13,000	9.03	18.39
14,000	8.73	17.78
15,000	8.45	17.21

EDWARD F. SCHAEFER, M. M. E.

Some Notes on Air Compressors.*

The following notes on air compressors may be found useful by engineers having charge of an installation, and may also prove of general interest in view of the increasing use of compressed air for industrial purposes. The compressor may be driven by a belt from the main shafting or by an electric motor, or it may have a steam cylinder affixed and be driven in this way, there being a large number of compressors of each type in use, convenience usually determining which method of driving shall be adopted. A modern well-designed compressor, like a good steam engine or pump, will run a long time with very little attention, maintaining a constant pressure in the receiver and automatically adjusting itself to the load.

As there is usually very little clearance space in the compressor cylinder, it is not safe to allow much play in the journals, for should the load go off suddenly the weight of the moving parts not being cushioned by the air, the piston may travel far enough to strike the cylinder heads and cause some damage.

The inlet and discharge valves may be either automatic or controlled, of the slide-valve type, driven from the shaft by an eccentric or the ordinary lift valve operated from the shaft by means of some kind of gearing. They usually require very little attention beyond an occasional cleaning once in six or twelve months, when the machine should be examined and the cylinder, piston and valves cleaned from any grit or hardened oil which may have gathered on them. The cylinder body and heads are usually provided with a water-jacket, through which water is circulated to carry away the heat generated in compressing the air. A small pump is sometimes provided for this purpose, but it may be dispensed with if a supply of water is available from the street mains, it only being necessary to connect the pipes and provide a tap to regulate the flow.

In some of the larger compressors the compression is carried out in two stages; the air, in passing from the one cylinder to the other, going through an intercooler, this usually being some arrangement of pumps round which water is circulated. The air is by this means reduced in temperature, which greatly increases the efficiency of the compressor, as the air expands when heated and this heat is lost in the receiver and the distributing pipes.

The receiver for the air compressor is usually a wrought-iron tank, constructed to carry a working pressure of from 80 to 100 pounds per square inch, this being a very common working pressure. The receiver acts as a reservoir, storing up the air when there is no demand for it, and relieving the compressor when there is a large demand, thus steadying the working load on the compressor. The packing in the heads of the compressor cylinder may be either rubber or asbestos, depending on whether the circulating water comes in contact with the joint; if it does, rubber packing will usually be found the most satisfactory. Cotton packing gives very good results on the piston rods and keeps them in fine condition if well lubricated and not too tightly screwed up. The oil used

* By William Burns, Jr., in *Power*.

in the compressor cylinder should preferably be a mineral oil, so that it will not carbonize in the valves and pipes and cause trouble. It may even cause considerable damage if the carbonized oil is allowed to accumulate in the pipes; for should the compressor get overheated and the air and vapor from the oil be in suitable proportion, an explosion may take place, due to this carbonized oil becoming red-hot and firing the mixture.

There have been several explosions from this cause. An occasional injection of soapy water into the compressor when it is at work is said to be a very good means of keeping the compressor and pipes in good order. There should be no need for this, however, if a suitable oil is used and used in moderation. The mouth of the suction pipe should be placed outside the building in a position where it will get air as cool and dry as possible and free from dust. The suction duct may be made of wood, the area being large in proportion to the area of the suction pipe on the compressor, a crane-meshed gauze being placed at the mouth to prevent any foreign substance being drawn in. The distributing pipes should be taken from the top of the receiver to get as dry air as possible, and when there is a long length of piping, the pipe should be given a fairly good drop away from the receiver and drainage chambers placed along the pipe at intervals and at the end. This is to take away the moisture which gathers on the pipes due to the air cooling in them. Branch pipes for the same reason should be taken from the top of the main pipe and not from the bottom, this also prevents the scale and dirt which gather in the pipes from choking the small pipes.

When the air is to be used in pneumatic tools, such as hammers and drills, there is usually a strainer placed at the end of the branch pipe to which the hose is attached, this strainer being made of fine brass gauze or cloth through which the air can pass. This retains all the scale and dirt, which, if it were allowed to get into valves and cylinders of the hammers, would soon tear them to pieces, the valves of some of the hammers being so light and the air passages so small that even a small piece of rubber off the air hose pipe is enough to put the hammer out of action. The area of the strainer is made large in comparison with the pipe, so as not to impede the air and to allow for an accumulation of scale and dirt. The joints in the pipes require very little attention if well made at first. They should, however, be periodically examined with a light, as a leak does not show up the same as on a steam pipe and considerable leakage may be taking place without one being aware of it. This is very apt to happen if the pipes are laid near where steam hammers are at work, as the vibration tends to loosen the joints and there may be enough air escaping in small leaks at the different joints to drive one or two pneumatic tools.

Mechanical Appliances for Coal Mining and Handling.*

Through the application of labor-saving machinery it has become possible to shovel coal from the working breast of a mine into the mine car, to pass it through the various processes of preparation, transport it some hundreds of miles by rail, empty it into a vessel and again carry it over long distances, discharge into cars, transport these to the consumer and deliver that coal into the furnace door under a boiler without it having been touched with a shovel more than the one time when it was loaded in the mine chamber. It is a long reach with one shoveling from the mines of West Virginia or Pennsylvania to a mill in interior New England, but it is done, and its doing is a triumph of American ingenuity.

It is not in the carrying alone that this advance has been reached. The numerous processes of mining—the cutting of the coal in the seam, drilling for the shot, hauling from the room to the shaft or entrance, handling between mine and tipple, methods and devices for handling, cleaning and preparing the coal for market, disposing of the refuse, and loading the coal on cars—all have been studied carefully, and mechanical means have been developed, which have done the work better, more rapidly and more cheaply than the old methods of hand labor.

In the actual work of mining—that is, of driving entries and cutting coal in the rooms—there has been rapid increase in the use of machinery, as is shown by the following data, given by Mr. Edward W.

By Henry S. Fleming in the *Mining Magazine*.

Parker, of the United States Geological Survey:

	No. of mining machines in use.	Tons of coal produced each year by machinery.	Per cent. of total by machines.
1891	545	6,211,732	6.66
1896	1,446	16,424,932	14.17
1897	1,956	22,651,140	16.19
1898	2,622	32,413,144	20.39
1899	3,125	43,963,935	23.00
1900	3,907	52,784,523	25.15
1901	4,341	57,784,523	25.68
1902	5,418	69,611,582	27.09
1903	6,658	77,974,894	28.18

The number of machines in use in the period given has increased 1,121 per cent. and the tonnage produced 1,155 per cent., while the percentage of machine-mined coal in the country at large has increased from 6.66 per cent. in 1891 to 28.18 per cent. in 1903.

In undercutting the coal, two classes of machines are used—the "pick" and the "chain" machine. The former strikes a direct blow like a miner's pick, undercutting about 14 inches at the face and tapering down to about 4 inches at the full depth. The coal so cut will, in a seam of medium hardness, average about 30 per cent. screened nut, while the cuttings from a chain machine, which cuts by scraping steel cutters against the coal, are all dust. On the other hand, the total undercut by a chain machine, taking a seam 5 feet thick and cutting 6 feet in depth, would amount to about 10 per cent. of the contents of the seam, while the pick machine would cut 15 per cent., of which 4½ per cent. would be nut coal and 10½ per cent. dust.

Among the better-known pick machines are the new "Ingersoll," "Sullivan," "Harrison" and "Wagner," the first three operating with compressed air and the last one by electricity. The "New Ingersoll" machine is mounted on wheels of 16 to 20 inches in diameter and weighs from 550 to 900 pounds. In operation it is placed on a platform of 2-inch plank, 3 by 8 feet, inclined to neutralize the recoil. Compressed air at from 40 to 75 pounds is used for power, and a regulator in the hands of the operator controls the number of blows between 160 to 250 per minute, and the force from 5 to 1,500 pounds. The machines are made in five sizes, for seams of different heights, undercutting from 4 to 6 feet. A balanced throttle on the air-supply port prevents racing when the pick fails to strike the coal, keeping the machine constantly under the control of the operator. The "Sullivan" machine also uses compressed air, and is provided with a cut-off lever to control the air expansion in the cylinder. The valve movement to regulate the number of strokes is controlled by a pointer on the back of the machine, which in turn adjusts the governor, so that the same number of strokes are given, whether the pick strikes or misses the coal. The machines are made in six sizes, undercutting from 4½ to 6 feet, and weighing from 500 to 850 pounds. The "Harrison" machine is another of the compressed-air type, provided with a regulating device to control the cut-off and regulate the number and force of the blows. Like the other machines of this character, it is simple in construction, compact and easily handled. The "Wagner" machine is one of the electric reciprocating type, generally known as "electric punchers." Its general appearance is the same as that of the compressed-air pick machine, which it is in reality, the electric current being used to compress the air by which the blow is struck.

Differing from the pick machines, the chain machines, whether for room or long-wall work, are required to undercut only to the thickness of the teeth on the chain or cutter, from 4 to 6 inches. Necessarily the coal so removed is in fine dust. In a 5-foot seam an undercut 6 inches high and 5 feet deep would give 10 per cent. of the face in slack coal apart from the fines produced in blowing down and loading.

Among the better-known machines of this type are the "Jeffrey," "Sullivan" and "Goodman," all of strong and simple construction, operated by electricity or, in some cases, by compressed air. The "Jeffrey" machine is of the latter type. Where electricity can be used, the cutter is operated by a motor of the multipolar type, having an iron-clad armature with two field coils. If compressed air is used for power, a double plain slide-valve engine is employed. The cutter and cutter-frame are the same in either case. For undercutting headings or in rooms, the chain machine is employed, cutting forward to a depth of 5 to 7 feet and a width of 39 to 44 inches. For long-wall mining the cutters are fastened to a wheel, making a lateral cut 3 to 6 feet deep, about

4 inches high. The "Sullivan" chain machine is operated by a vertical, multipolar shunt-wound D. C. motor. It cuts forward into and then follows across the face of the breast, the cut being from 5 to 6½ feet deep and about 5½ inches high. The long-wall machine, made by the same people, is similar in general character to the breast machine, some slight modifications adapting it especially to this class of work. It undercuts from 3 to 5 feet and clears itself in the cutting.

The "Goodman" chain-breast machine undercuts with a forward motion, the cut being from 5 to 7 feet deep and 42 to 48 inches in width. A "standard" and a "modified" form of long-wall chain machines are made by the same company, the latter reversing and cutting in the opposite direction, the pulling of the machine against the face being prevented by a guide arm.

The following table is interesting, as showing the percentage of coal mined by machine, and the kinds of machinery used in the several States:

State.	1903. Per cent. of total product mined by machines.	Number and Kinds of Machines in Use. Pick.	Chain breast.	Long wall.	Total.
Alabama	4.95	89	9	...	98
Colorado	17.11	88	65	4	157
Illinois	19.97	451	100	2	553
Indiana	30.90	110	219	...	329
Indian Territory	2.08	16	18	2	36
Iowa	.86	...	...	10	10
Kansas	.17	...	3	2	5
Kentucky	37.73	202	105	1	308
Maryland	8.28	36	...	...	36
Michigan	13.23	46	...	...	46
Missouri	7.35	4	...	29	33
Montana	46.58	61	2	...	63
New Mexico	9.40	...	12	...	12
North Dakota	41.35	2	7	...	9
Ohio	56.39	51	673	...	724
Pennsylvania	36.02	2,267	1,039	4	3,310
Tennessee	6.35	45	6	...	51
Texas	3.13	6	2	...	8
Utah	4.46	13	...	...	13
Virginia	2.38	...	10	...	10
West Virginia	27.93	358	430	...	788
Wyoming	16.91	42	17	...	59
Average	28.18	Total, 3,887	2,717	54	6,658

Power drills for cutting holes in the face to shoot down coal which has been undercut are employed whenever electricity or compressed air is used in the mine. Drills for this purpose, to be operated by either form of power, are manufactured by each of the makers of the mining machines mentioned. Another, the "Howells" drill, largely used in the anthracite regions, operates with compressed air; it uses about 36 cubic feet of free air per minute at 50 to 75 pounds, and bores a 6-foot hole from one to one and one-half minutes. The "Wagner" drill is conveniently arranged to operate from the same electric motor used on the pick machine. The "Jeffrey" drill operates with compressed air or electricity.

One of the most effectual savings in coal mining has been accomplished by the introduction of mechanical haulage through the mines to the shaft or tipple. The maximum capacity of any mine is the tonnage which can be taken through its main entry. Mechanical haulage has more than doubled the ton-mileage of the cars, and in thus doing has added that much to the capacity of the openings. As the total operating cost for almost any class of plant for such purpose is less than two-thirds of the feed and keep of the mules and wages of the drivers formerly employed, the haulage cost per ton has been reduced nearly 40 per cent. In the early efforts in this direction both the tail-rope and endless-rope systems were applied,

but these have been replaced by mine locomotives, operated by compressed air or electricity, according to the requirements of the mine.

Of the former type, both the "Baldwin" and "Porter" compressed-air locomotives are well known and largely used. The "Baldwin" varies in size from one weighing 10,000 pounds and having a tractive power of 1,350 pounds at full stroke, hauling 18 tons on a 1 per cent. grade, to one weighing 44,000 pounds, with 9,140 pounds tractive power, hauling 197 tons on a 1 per cent. grade. The "Porter" engines are of about the same capacity. A statement of the comparative cost of haulage by mules and by "Baldwin" locomotives at the Shenandoah Colliery of the Philadelphia and Reading Coal and Iron Company, per year of 180 working days, gives a total cost with mules of $6,052.50, and with compressed air of $4,264.33, thus showing a saving of $1,788.17, exclusive of a large reserve haulage capacity in the air locomotives. At the Mill Creek Colliery comparative results with a "Porter" compressed-air locomotive showed a cost with mules, per year of 180 days, on two levels, of $7,249.50, as against $3,455.28 with the locomotive. Figured on ton-miles, the cost with mules was 7.92 cents, as against 3.77 cents with air, a saving of 4.15 cents.

In mines where there is little danger of explosion from gas or dust, electric locomotives have certain advantages. Electric power can be economically carried for longer distances than compressed air, and the same current which is used to drive the electric locomotive can be conveniently utilized for coal cutting or drilling machinery, pumps or any other needed application of power.

Of the several electric locomotives for underground haulage, those probably best known are the "General Electric," "Jeffrey," "Baldwin-Westinghouse" and "Morgan," the first three feeding from a trolley touching an overhead conductor and the last one having a gear wheel engaging a concealed "third rail" located between the tracks. These locomotives are made in several styles, according to the height of the seam, and in weights from 6,000 to 40,000 pounds. For gathering from rooms, an ingenious reel device is sometimes provided, which enables the locomotive to operate at a distance from the main trolley wire.

The comparative cost of mule and electric haulage at the Green Ridge Colliery, near Scranton, Pa., is given as follows:

Total cost per day, mule power	$20.60
Cost per ton, mule power..	7.15 cents.
Total cost per day, electric power	$7.96
Cost per ton, electric power	2.76 cents.

At the Forest City mines of the Hillside Coal and Iron Company the comparison was

	No. 2 Shaft.	Forest City Slope.
Mule power, per day......	$86.98	$40.38
Electric power, per day......	21.67	11.97
Mule power, per ton......	8.79 cents.	7.47 cents.
Electric power, per ton......	2.19 cents.	2.21 cents.

Another device of great service is that which enables mine cars to be hauled up and down an incline in steady succession, instead of on the former plan of trips of several cars held by a "dolly" car. At the tipples themselves new devices have been adopted both for carrying the loads forward and returning the empties by gravity and in the construction of the tipple; the later forms move rapidly, discharging completely and automatically, throwing back the empty cars. Transportation from the mines has improved vastly through the use of larger cars, carrying from 40 to 50 net tons, and the heavy expense of loading into box cars has been largely reduced through ingenious mechanical appliances for the purpose, with the result that a much greater percentage of the coal is shipped in closed cars than formerly. The hand-loading method in box-cars was an expensive one, both as to the actual cost of handling the coal in the cars and the delay to the mines by reason of the slowness of the work. Loading by hand, only four men could work on a car, two on each side of the coal pile in the centre of the car, and handling about 250 tons daily. This was sometimes increased by keeping relays of men, one set of which worked harder to load a single car, and another set took their places while they rested. Even by this method it was not possible to load more than 600 tons per day in box-cars. Then, again, as the box or closed cars were only a part of the car supply, it

was not always easy to get men at the proper time for doing the box-car loading, and much delay was occasioned on this account.

One of the first box-car loaders on the market was the Ramsey, consisting of a long beam, or sweep, that swept across a table in the centre of the car, knocking coal from this table to the ends of the cars. The breakage of coal and cars became a serious matter, and many railroads declined to allow their cars to be used. A second Ramsey loader, of a different type, came out and helped remedy these difficulties. About 1898 the Ottumwa loader was put on the market. The coal was received in a hopper some 13½ feet long, supported clear of the car but worked inside of the car back and forth alternately toward each end. This hopper received the coal and carried it toward the ends of the car, where it was pushed out from the end of the hopper. The machines have a capacity of from 150 to 200 tons per hour. Since that time the "Smith," "Victor" and "Christy" loaders have come out and given good results.

Where the coal is delivered at tidewater ports for shipment by sea, there has been a change in the carrying capacity of the sea-going vessels and barges used for that purpose. The former barges and sailing vessels holding 1,000 tons or less have been replaced by larger ones carrying from 1,000 to 5,000 tons. There are in the coasting service, employed in carrying coal, nearly 1,600 ships and barges, with a capacity of 1,400,000 tons, of which 500 have a capacity of 900,000 tons, and of these 110 carry over 400,000 tons.

It is necessary to discharge large cargoes expeditiously in order to avoid demurrage on the boats, and for this purpose, as well as for carrying the coal from the pier to storage piles and reloading from these piles to railroad cars for final delivery, various ingenious mechanical appliances are employed.

Tunnels and Bridges.

One of the most marked developments in modern engineering, particularly within the past half dozen years, is the increased use of tunnels for passage under rivers near large cities, although in some cases for continuous lines of transit like the subways of New York and Boston, and those under discussion for a number of large cities. Some engineers of prominence have for many years advocated the construction of tunnels under rivers to a far greater extent than has hitherto been done, rather than the building of bridges over them, but on the whole it may be stated that tunnels have until lately been built in practically no places where it has been feasible to build bridges. That situation, however, is now essentially changed and the change is due to a number of reasons so substantial that the use of tunnels is likely to extend in a marked manner in the near future.

Projects for bridging both the North and East rivers at New York have been floating in the minds of agitators, promoters and some prominent engineers for many years, in fact for fully a hundred years; but projects for tunneling these rivers have been comparatively rare, the only exception of much consequence being that of the North River tunnel begun not far from twenty-five years ago and now practically completed. Indeed it is well known that the Pennsylvania Railroad Co. itself was at least indirectly interested in a project for a single-span bridge across the North River within a half dozen years, and practically the same observation may be applied to two or three other railroad companies with lines approaching New York City from the West.

With comparative suddenness the situation is now changed so that any private enterprise for bridging either the Hudson or the East rivers has little or no chance for a successful issue. It cannot be maintained that this condition is peculiar to the City of New York, although there are found at that point highly accentuated features. Tunnels have been built under the Chicago River for many years and the Sarnia tunnel under Detroit River has afforded passage for Grand Trunk trains for nearly the same period, and another tunnel is soon to be constructed at Detroit. The East Boston tunnel is also a case in point, showing the availability of this system of communication between cities or portions of cities. It is not meant by these observatons to intimate that bridges are now becoming obsolete but simply to show that communication by tunnels is being rapidly developed.

It is but a truism to state that as a rule the most economical means of com-

munication will be adopted wherever the question lies between tunnel and bridge, but it is interesting to analyze the matter a little closer in the attempt to ascertain why tunnels have become so popular in so short a time, although a sub-surface line of communication is far less agreeable to follow than one above ground. In the first place various methods of tunneling have been greatly developed, so that systems of construction have become simplified and made much more economical than formerly, at the same time materially enhancing safety, both in construction and operation. The tunnels completed recently in Boston and New York exhibit in a remarkable manner not only great improvements in the design and use of shields, but also the highly enhanced economy which has been reached in tunnel construction by the aid of compressed air. The process of forcing a shield through soft material as a mole forces its way through the ground, *i. e.,* without excavating the material, is sufficient to account for the economy of that particular tunnel under the North River in which Mr. Jacobs, the chief engineer, attained those results; but that is exceptional. The regular or standard use of the shield has been so far developed by improvements in design and by increased skill and efficiency in its employment that railway tunnels can now be built through any soft material, or material not hard, at a reasonable expense where the cost formerly would have been prohibitory. Even this feature of the subject, however, is probably not sufficient for a complete explanation of recent tunnel developments.

A careful consideration of all the conditions attending the construction of a great bridge in a city or in its vicinity where real estate has high value will disclose the influence of undoubtedly the most important agent in this class of problems. A great bridge requires a relatively large area of ground for its approaches and the higher the structure as a rule the greater will be the area occupied by those approaches. The high cost of real estate, especially where covered by buildings, is a most serious handicap, which has sometimes proved fatal for a bridge project when its approaches must occupy that kind of a territory. This condition has been illustrated in a most emphatic manner by the cost of the approaches for the suspension bridge across the East River at New York. The actual cost of bridge construction is relatively a small matter compared with the enormous costs of real estate required for such high level structures. The approaches of a tunnel on the other hand involve little or no expense for real estate. Some rights may occasionally be trenched upon, but as a rule the cost of a tunnel is the cost of its construction only, requiring a light outlay if any for approaches. The grades leading to a bridge structure must be easy, so that the traffic which it accommodates may readily attain the roadway of the structure. If the latter is at considerable elevation, as is usually the case, an approach structure sometimes longer than the actual bridge itself is required. If, as in many cases, approaches leading in several directions are required the case is aggravated. These comparisons hold true even where a tunnel line comes to the surface within thickly populated districts, as is frequently the case. The approach in such an instance is simply a hole in the ground with an excavation leading to it, the purchase of real property being reduced to a very small matter.

It is practically certain that tunnel development for city lines of transportation has but begun. The methods and materials required to make the passage of a tunnel agreeable are now abundantly available at low costs, so that while probably no one would prefer an underground passage to one on a bridge the difference in attractiveness between the two systems has been reduced to an extremely small fraction of what it was but ten or twenty years ago. On the other hand the enormous carrying capacity which must be given to such bridges at the present time increases their costs not only as structures but also much more in consequence of the greatly extended approach accommodations required. With the increase in population of great cities, therefore, a tunnel proposition is almost inevitably bound to arise wherever lines of transportation are required across rivers, and the existing tendency toward subway construction appears to indicate with equal certainty that sub-surface lines of transportation are sure to gain the ascendency in intermural locations where the density of population reaches that already attained in many American cities. —*Engineering Record.*

Notes.

Could the drills be operated at long range by compressed air, Washington might be able to supply power for the work on the Panama canal.—*Omaha* (Neb.) *Bee.*

The pneumatic wood-boring machine is in use on the South Side Elevated in Chicago, where it is regularly boring 15-16 inch holes through 14 inches of green oak. —*Engineering and Mining Journal.*

The Vacuum Cleaner Company, of New Haven, Conn., has filed articles of incorporation. The company has an authorized capital stock of $100,000, and it proposes to establish vacuum-cleaning apparatus in various Connecticut cities.

Liquid Air Power and Automobile Company of Great Britain, Ltd.—£3,300 debentures, created 21st August and dated 9th November, 1905, charged on the company's undertaking and property, have been registered. No trustees.—*Ex.*

General Herman Haupt, an authority on the subject of compressed air, died suddenly on the morning of December 14th, while returning from New York to Washington. A sketch of the career of this distinguished engineer will be given in the February issue.

A letter has been forwarded to the Post Office Department by the Brooklyn League, asking if it were not possible for the government to own or control the pneumatic tube mail service. The letter says that since the discontinuance of the tube service the Brooklyn mails have been delayed an average of about fifty minutes. —*Ex.*

The second instalment of Frederick Trevor Hill's new and careful study of "Lincoln the Lawyer," in the January *Century*, will deal in detail with the young Lincoln's law studies, his admission to the bar, his first law partnership, and his early struggles and competitors. There will be reproductions of a number of interesting documents and portraits.

Fine flake graphite is a valuable lubricating medium for rock drills. When drills are assembled after cleaning, it is a good plan to apply graphite to the moving parts; it imparts a desirable smoothness to the operation of the machine, as well as allowing the quantity of oil used to be considerably reduced.—*Engineering and Mining Journal.*

In the description of the compressed air plant of the Pittsburg Gas Coal Company at Iselin, Pa., published in the September number of COMPRESSED AIR, an error was made in the number and make of the coal-mining machines in use at the Iselin Mine. There are at present 63 coal cutters in service, of which 40 are the "New Ingersoll" type and 23 of Sullivan make.

When a drill-bit sticks in a hole, the usual remedy is to strike the shank violently with a sledge until the bit is loosened. It is better to strike a moderate blow on the shank, near the hole, and never so high up as to strike the chuck, because then a bent piston or a broken chuck is likely to result. Small pieces of cast-iron, nuts or other fragments are used to keep the drill straight and prevent sticking or "running off."—*Ores and Metals.*

The great advantage of machine coal-cutting consists of the reduction of mining costs, as well as in the enhanced value due to less breakage and to the increased safety. As breakage affects, to a great extent, the price which may be obtained for the final product, every practicable means is taken to guard against it, and the machines themselves are designed to effect the removal of the coal with as little breakage as possible.—*Engineering and Mining Journal.*

The Chicago Pneumatic Tool Co.'s quarterly report to its shareholders has recently been issued. The report is for the period ending September 30 and shows a profit of $241,791.45. Depreciation and other items, bond interest for the quarter, and sinking fund reserves subtracted from that leaves $168,053.16 available for dividend. From that is taken the quarterly dividend No. 11 for $61,137.83, leaving $106,915.33, the balance carried to surplus. The surplus now amounts to $483,-813.50.

It is a little late to institute comparisons commendatory or condemnatory as to the relative merits of electricity and compressed air in mining operations. They are not competitors, but coadjutors. There are cases when either one is better than the other. The point is to determine in the particular case mentioned whether it were more economical or practicable to use water power, steam, electricity or compressed air, or any two or all, and to let it go at that.—*Mining Reporter.*

The economical use of compressed air has been greatly augmented by the introduction of the inter-cooler between the cylinders of a compound compressor and the after-cooler between the high pressure cylinder and the air tool. It is now proposed to reheat the compressed air just before using it, on the theory that as air is heated it expands and will exert a greater force or pressure. The economy of this procedure is admitted in theory, and its practice is now being investigated by pneumatic engineers.—*Mining Reporter.*

A new catalog, entitled "Rock Drills," has just been issued by the Chicago Pneumatic Tool Company. It notes that the Chicago Pneumatic Tool Company has decided to further extend the scope of its business by entering into the sale of rock drills for mining, tunneling and quarrying work generally, and to this end has effected an arrangement whereby it has secured the selling rights to the McKiernan rock drills. The catalog lists the new line of Chicago McKiernan drills, together with such accessories as are needed for rock drills.

Compressed air locomotives, which in the past few years have become so largely used for mine haulage, work under pressures ranging from about 500 to 2,000 pounds. The pressure is mainly determined by the size of the locomotive permitted by the tunnels and curves. In tunnels of good size the large reservoirs needed for low-pressure engines are permissible, while where but small receivers can be used in the motors, it is necessary, in order to carry the required supply of power, to compress the air to much smaller compass in strong steel tubes.—*Mining Reporter.*

Bronze or metallic powders are produced by Mr. Baer by a novel method that has been patented in France. The melted metal or alloy is run through a slot into a sheet-iron box or cylinder in which a shaft with paddles is rapidly revolved, or into a chamber into which compressed air is suitably injected. Movement of the air converts the metallic rain into thin leaves by the time it solidifies. The thin leaves may be reduced to powder by beating, grinding or other means. Neutral gases—such as a mixture of nitrogen and carbonic acid—may be used to avoid the oxidizing action of the air.—*Ex.*

We have received an inquiry as to the applications of compressed air in textile factories which may be of interest to our readers. The chief purpose for which compressed air is used in industries of this nature is for cleansing the fabric. This is done by first heating it and then blowing the air through it. The grease is easily removed in this way. One large cotton mill in New Orleans uses compressed air as the motive power for a small tramway, which moves the goods from one point to another. The danger from fire is so great that the steam and electric locomotives were rejected in favor of the pneumatic engine with its absolute freedom from fire.

The Maine Central Railroad has just fitted up an air-brake instruction car for service on that railroad. The car is divided into three sections, one for the engine room, one for the instruction room, and the third for the office of the instructor. In the engine room an air compressor, driven by a six horse-power chemical engine, is used when there is no other supply of compressed air available. This equipment is capable of furnishing air at a 130-pound pressure. The car has all the brake parts of a train, consisting of engine, passenger coach, and 20 freight cars. The car has been put into commission, and will go from station to station, giving instruction of the operation of air brake.

In coal-cutting machines operated by compressed air, the exhaust ports used to give trouble by freezing, due to the entrained moisture and to the small cross-section of the passage. This is not

the case at present. Most of the modern machines are so designed that the expansion is more gradual and the cooling effect less local. Trouble of this sort is rare except in cold workings, when the natural temperature is low enough to add a cumulative effect. The heat developed in the compression cylinders, and the cold produced in the expansion cylinders of compressed-air machinery, furnish interesting examples of "the conservation of energy."—*Engineering and Mining Journal.*

Some interesting particulars are given of actual measurements just taken proving the wonderful accuracy with which the Simplon Tunnel has been driven through the Alps. Mr. Francis Fox, in a letter to the *Times*, says the length of the tunnel, which is 12½ miles, proves to be greater than was planned by 31 inches. The levels of the two galleries were within 3½ inches of one another. As to direction, the axis of the tunnel, driven from the north end, deviated 4⅓ inches toward the west, while the line driven from the south end deviated 3⅔ inches toward the east; consequently, the greatest divergence from the true line was 4⅓ inches, which is well within the calculated "probable" error.—London *Globe* (Eng.).

The general use of compressed air in railroad boiler shops, which has been the principal factor in advancing boiler shop practice to a foremost place in railroad mechanical departments, is being extended at some shops to include the cleaning of crown bars and crown sheets with a sand blast. It is declared to be a big improvement over the old way with hammer and chisel. In a western shop where the sand blast is being used, it formerly took a 17½-cent man ten hours to clean a dozen bars—$1.75 for the lot. With the sand blast a bar is cleaned in from twenty to thirty minutes, or in about half the time of the old way, and the blast makes a cleaner job. This same shop uses the blast for crown-sheet cleaning with satisfactory results.—*Railroad Gazette.*

Our Newcastle correspondent states that the Shipbuilding Employers' Federation and the Boilermakers' Society's representatives have come to an amicable settlement of the dispute with regard to the working of pneumatic tools in shipyards, or, rather, the reduction which should come off hand rates in favor of the machines. Percentage deductions have been agreed to, and these will come in force on the first full pay in December. The settlement of this important question will have a great effect on the shipbuilding trade of the country, for many of the larger firms have only been awaiting something approaching a satisfactory basis of payment for labor in order to re-equip their yards on the most modern plan.—London *Daily Telegraph.*

Engineering methods are coming to the help of the architects in two works of national importance. As everyone knows, the "Auld Brig" of Ayr is in a dangerous state, and a new iron bridge has been recommended. "Not at all," says Mr. Francis Fox, the engineer; "let me grout it, and it will last another hundred years." Winchester Cathedral also is in danger of collapsing. "Grouting" is again recommended by Mr. Fox, who undertakes to save and strengthen the beautiful building. By the grouting machine invented by the late Mr. Greathead for tunnel purposes, liquid cement is blown by compressed air right into the heart of any wall, no matter of what thickness, and the whole is practically turned into a monolith.—*Railway News* (Eng.).

The subject of pneumatic tubes for carrying mail is dealt with in the annual report of Postmaster-General George B. Cortelyou, which has just been completed. An appropriation of $1,233,676.84 for pneumatic tube mail service for 1907 is recommended. Pneumatic tube service is reported now in operation in the cities of Boston, New York, Brooklyn, Philadelphia, Chicago and St. Louis. In Boston, Brooklyn and Chicago the full service contemplated by the contracts is in operation. The lines in Chicago were completed within the past year. The lines in New York, Philadelphia and St. Louis have not been completed. The service in operation on June 30, 1905, covered about 26 miles of double tubes, at an annual expenditure of $401,023.84. The extent of the service now under contract is about 51 miles, for which the annual expenditure is $822,191.74.

Owing to the magnitude of the works of the Westinghouse Electric & Manufacturing Company a great many people

have received an erroneous impression that the product of this Company consisted principally of only the larger types of electrical apparatus, especially so with reference to electrical generating units. This wrong impression is largely due to the fact that most of the great power plants of the country, having the largest units, are equipped with Westinghouse generators and auxiliary apparatus. The aggregate business of this Company, however, in the smaller units far exceeds that of the larger and special types. They manufacture every kind of electrical apparatus for either light or heavy work and their instruments for measuring electrical energy equal in delicate construction the works of the better class of modern watches. These instruments are recognized standards in their field.

The common method resorted to by typewriter operators of brushing away by the hand the particles resulting from an erasure from the paper is objectionable for several reasons. When copying ink is made use of, the passage of the hand across the paper makes a smear, and in blowing away the accumulations, unless done with great care, one is liable to dot the page with blots of moisture. A combination rubber and blower has been invented by C. S. Magill, of Owensboro, Ky., to meet this purpose. An eraser of standard type is used in which a hole is bored. The eraser is fitted into a rubber bulb and serves as a nozzle of the syringe. In use the eraser is held with the bulb in the palm of the hand. After rubbing out the desired mark, the eraser is lifted a trifle from the paper so as not to close the air duct, then on squeezing the bulb the dust and dirt of the erasure will be blown away. When one eraser is used up it may be removed and another inserted in the bulb.—*American Exporter.*

In the construction of the extension of the Chicago Stock Yards the contractors are utilizing, to a greater extent than usual, the pneumatic boring appliances. The popular idea is that the field of application of pneumatic tools is limited chiefly to iron work, where the hand work displaced is very laborious. Recent experience appears to show that the less laborious but equally tedious manipulation of wood can be more economically done by power tools, and at the present time pneumatic appliances are the most convenient portable tools available for the purpose.

At the stock yards an improvised car was built, carrying an old street car electric motor, to which was attached an air compressor, current being taken from a near-by trolley system. It is reported that one-inch holes are being bored through fourteen inches of green oak with a pneumatic boring machine, two of which are doing the work formerly accomplished by twenty men under hand labor conditions.—*Ex.*

The University of Kansas, at Topeka, has the only liquid air factory west of Michigan. For the last five years the chemical department of the university has had an outfit costing $2,000 that has a capacity of $3.50 worth of liquid air an hour. The only colleges with equipment for manufacturing the frozen air are Cornell, Connecticut, Wesleyan, Michigan and Kansas. There are factories in Washington and New York for making the air for commercial purposes. The Cornell plant was the first equipped, and Kansas was second.

The Kansas liquid air machine was not installed to make the air to be sold. Its primary use is for experimental purposes; that is, to make liquid air to be used in the chemical laboratories of the university. However, any one may send $10 to the chemical department of the University of Kansas and receive in return a five-gallon flask of real liquid air, ready for any of the familiar experiments of freezing mercury and boiling water.

Liquid air has been sent from Kansas to many places for experimental and scientific purposes. The demand for the output is increasing so that it has averaged more than 100 gallons a year since the plant has been installed.—*Ex.*

The use of compressed air for shaft sinking or tunneling was at one time regarded as a last resort—an extreme measure to be adopted when others had failed. Due to the persistence of beliefs, once they have gained general acceptance, compressed air has not been used so extensively as it will be in the future, and as it deserves to be used at present. Elsewhere in this issue Mr. F. I. Winslow describes the construction of an 8-foot tunnel, only 100 feet long, at Boston. Both

in sinking the shafts and in driving the tunnel, compressed air was used without the use of a shield. Due to the light air-pressure—24 pounds and less—long shifts were worked without injury to the men.

Such work as this should be very suggestive to engineers and contractors having deep sewers to build in soft ground. Often the attempt is made to build a large sewer in a deep open trench, requiring a great expenditure of money for bracing, for pumping, for excavating, for back-filling, and for repaving, to say nothing of the inconvenience and loss to those who have to use a congested and torn up street. We believe that as it becomes more generally known that compressed air is not a dangerous and mysterious agency for tunnel work, there will be fewer deep trenches in wet ground and more small tunnels. We shall welcome any further contributions on the ways and means of doing this kind of work, and particularly any data showing rates of progress and size of working force. Many large tunnels have been described, but there is singularly little in print on the driving of small tunnels in soft ground.

The *Horseless Age* publishes the following inquiry and reply regarding the use of compressed air for starting gasoline engines:

"I want to ask for some information with regard to starting a six-cylinder 7 by 7-inch gasoline engine by compressed air. What I wish to know particularly is how to connect the air to the engine. We are building the engine ourselves.

J. E. W.

"[In order to start a gasoline motor by means of compressed air you require a shifting exhaust valve cam shaft with two separate cams for each cylinder, one cam operating when the engine is driven by the explosive force of gasoline vapor, and the other when it is driven by compressed air. The latter cam has two oppositely arranged cam prominences so arranged as to keep the exhaust valve open during each upward stroke of the piston. The two cams for each cylinder should be in one piece, and be at a considerable distance from each other (equal to the width of the cam roller at least); their adjacent faces should be slanted at least 45 degrees, so that the cams can be pushed under the cam rollers. For the air inlet a special poppet valve must be provided for each cylinder, mechanically operated during each downward stroke of the cylinder. This poppet valve must be so arranged that it is closed by the pressure in the air tank. From this valve a small pipe leads to the inlet pipe just outside the regular inlet valve. The inlet pipe must be sufficiently strong to stand this pressure, and the gas throttle valve must be so designed that it can be completely closed.—Ed.]"

The fifty-second meeting of the American Society of Mechanical Engineers was held in New York city during the first week in December. The headquarters, instead of being at the Society House, 12 West Thirty-first street, as in previous years, was at the Edison Building, 44 West Twenty-seventh street, the two upper floors being used.

The opening session, at which President John R. Freeman presented the annual address, was held at 44 West Twenty-seventh street on Tuesday evening, December 5. The second or business session was held Wednesday morning in the main saloon of the steamship "Amerika," at the docks of the Hamburg-American Line, at Hoboken, N. J. Following this session a special train took those desiring to make the excursion to the new Henry R. Worthington Hydraulic Works, at Harrison, N. J.

Wednesday evening there was an illustrated lecture at 44 West Twenty-seventh street, by Prof. R. W. Wood, of Johns Hopkins University, on "Photography of Invisible Phenomena."

The third session was held on Thursday morning at 44 West Twenty-seventh street, and besides the presentation of professional papers, there was a discussion on the subject of "Bearings." Thursday afternoon there was a reception at the New York School of Automobile Engineers, 146 West Fifty-sixth street. The usual reception at Sherry's took place on Thursday evening. The closing session was held at 44 West Twenty-seventh street on Friday morning, and was devoted to the presentation of professional papers.

Experiments in extracting worn or broken brick from pavement by the use of pneumatic tools were recently conducted at the Chicago Pneumatic Tool Co.'s plant, Denver, in the presence of

Public Works Commissioner Haarer and Joseph S. Boyer, president of the company, according to a press dispatch.

By the use of a compressed-air-driven drill, a brick was removed from a pavement in which it has set for the last five years in just 10 minutes. By using an air-driven chipping hammer, one was taken out in five minutes. A workman handling a chisel about four times faster than Haarer said he ever saw a city employe work, took a brick out by the ordinary method in 12 minutes.

"There is no question but that the pneumatic tools do faster work in removing single bricks than men do," said Mr. Haarer, when the experiments were ended. "There is no comparison between the two sorts of work. But these tools are only designed to lift a single brick out of the pavement here and there, wherever one is found worn or broken. Seldom is a single badly worn brick found in one place. Usually, we meet with a hole in the street, where six or eight bricks need to be removed, and as many good ones put back. Well, lift one with a crowbar and the rest will come easy.

"In the use of the pneumatic tools, a compressed air machine is, of course, needed, and the city would need a portable one for its purposes. The whole outfit would cost, I am told, about $800 or $1,000. I do not know what the cost for removing one brick would be compared to the cost for removing one by the method now employed."

The matter of raising the legally required percentage of air-braked cars in a train on which a hearing was held by the Interstate Commerce Commission as reported in our issue of November 9, has now been decided by the Commission. An order has been issued raising the required proportion of air-braked cars in a train to 75 per cent., to take effect August 1, 1906. The present legal requirement is 50 per cent.

Judging by the showing made at the recent hearing, the railways will experience no serious difficulty in meeting this requirement on interstate traffic. Out of about 1,900,000 freight cars in the United States on October 1, 1905, according to the Interstate Commerce Commission figures, only about 225,000 are still without air brakes. To a large extent these are old cars of small capacity which have not been deemed worth the application of brakes. If these cars are to continue in service at all they ought to be relegated to local branch lines where they will not handle interstate traffic. To run such cars in general interchange is a standing invitation to accident every time one of these old and weak cars is made up in a long train. If the Commission's order tends to shut out these old cars from general interchange it will be for the benefit of the railway companies.

Of course a considerable proportion of such cars can still continue to run with little risk of enough cars getting into a train to exceed the legal limit of 25 per cent.; but there can be no doubt that the legal limit will soon be raised to 100 per cent. In other words, every railway car will soon have to be equipped with air brakes as it is now equipped with automatic couplers. The original law and the present order aims to give the railway companies a reasonable time for equipping their rolling stock, but dilatory action will certainly result in penalty.—*Engineering News.*

While only the other day complaints were received on the part of artisans in the Royal Dockyards regarding the harmful effect of being compelled to handle the pneumatic tools now largely in use for caulking and chipping and riveting in ship work—complaints which were discredited entirely by the medical officer appealed to by the dockyard authorities—it is of interest to learn that no such objections to the use of these labor-saving appliances are urged by the workmen in private yards. On the contrary, it is significant that an agreement has been come to between the Federated Shipbuilding and Engineering Employers, both in Scotland and England, and the Workmen's Society, not only to encourage the members to avail themselves of the tools which the employers have, at great cost, provided, but to allow a very substantial reduction on the rates of pay for work done by their aid. On and after to-day, and for a period of at least six months, the workmen handling these tools will do so at a reduced scale of pay for work done of 40 per cent. on shell plating and 35 per cent. on interior work generally. This arrangement will be introduced into yards where these tools have for a number of years been looked upon with anything but favor by the great bulk of the workmen. The fact of

such a substantial reduction in workmen's rates being allowed by the Workmen's Society officials is eloquent testimony to their labor-saving qualities. The work is not only done more rapidly, but is of a higher quality than hand work, although in the matter of riveting, perhaps, there is still something left to be desired. In America, on the other hand, riveting is as largely done by these tools as is in the case of chipping, caulking and drilling. In a paper read on the 24th ult. before the Northeast Coast Institution of Engineers and Shipbuilders, at Newcastle, by Mr. Charles Schofield, cabled assurances were read from a number of United States firms, giving the extent to which these tools were employed even for riveting of ships. The statements created something of a sensation amongst the assembled employers of the Northeast Coast and their managers. In reply to the request: "Will you be so good as to cable me the approximate percentage of the entire number of rivets in the shell of a ship which you are now driving with pneumatic tools?" the author received a cablegram from the American Shipbuilding Company: "Eighty-five to ninety per cent.;" from the Newport News Shipbuilding Company: "Thirty in shell, eighty in hull;" from Cramp's Yard, of Philadelphia, where Mr. Schofield was manager for seven or eight years: "Ninety-nine;" and from the Maryland Shipbuilding and Steel Company, Sparrows Point: "One hundred." Thus every rivet is closed, in some cases, by pneumatic appliances; and, further, food for reflection is provided by the fact that this is accomplished by what in this country is termed "unskilled labor," the tools being operated by men or youths who have served no apprenticeship in riveting.—*Engineer* (Eng.).

Seats are reserved at all the Proctor theatres, both afternoon and evening. Patrons may have these tickets mailed to them upon sending check or money order, or they will be held in reserve at the box office until the performance required. Telephone communication will receive prompt and courteous attention. Seats for the four New York houses are on sale at all principal hotels and newsstands.

INDEX.

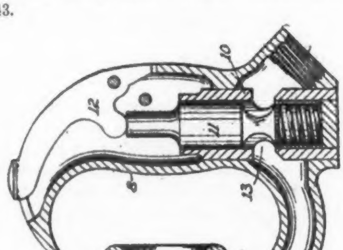
U.S. PATENTS GRANTED NOV., 1905.

Specially prepared for COMPRESSED AIR.

803,564. AIR-BRAKE MECHANISM. John Dillander, San Francisco, Cal. Filed Oct. 6, 1904. Serial No. 227,432.

803,591. DOUBLE-HEADING VALVE DEVICE FOR AIR-BRAKES. Herbert T. Herr, Roanoke, Va., and Walter V. Turner, Wilkinsburg, Pa., assignors to The Westinghouse Air Brake Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed Feb. 2, 1904. Serial No. 191,645.

803,621. PNEUMATIC HAMMER. Allen J. Patch, Beloit, Wis., assignor to Fairbanks, Morse & Co., Chicago, Ill., a Corporation of Illinois. Filed Dec. 28, 1903. Serial No. 186,-843.



A pneumatic hammer comprising in combination a cylinder, a piston, a main valve located at the rear of said cylinder and controlling certain ports and passages for admission of fluid pressure to said piston and exhaust of pressure therefrom, and a supplementary valve at the forward end of said cylinder controlling the exhaust from such forward end and in itself controlled by fluid pressure admitted to and exhausted by means of the main valve.

803,684. FLUID-PRESSURE POWER-TRANSMISSION APPARATUS. John W. Hall, Brixton, England, assignor to Hall's Transmission Gear Syndicate, Limited, London, England. Filed Mar. 14, 1903. Serial No. 147,706.

In a power-transmitting device the combination of a shaft, extending entirely through the device, and a rotary casing constituting the driving and driven members, a pressure-creating device, such as a pump, having one of its elements connected with the driven member and its co-operating element connected with the driving member, an adjuster in controllable communication with the pressure-creating device or pump and controlling the movement of the driven member with means for varying the relative capacities of the pressure-creating device or pump and the adjuster.

803,659. PNEUMATIC TIRE. Arthur S. Allen, Brookline, Mass. Filed Nov. 12, 1904. Serial No. 232,412.

803,686. FLUID-PRESSURE CONTROLLER. George W. Furbeck and Albert N. Carver, Chicago, Ill. Filed Mar. 10, 1900. Serial No. 8,171.

A valve for controlling the passage of a fluid under pressure, in combination with two coiled springs adapted to alternately exert tension on the valve to move it in opposite directions, fluid-pressure-actuated mechanism, a fulcrumed lever connected to the ends of such springs, a rod reciprocated by said fluid-pressure-actuated mechanism and connected to the lever at one side of its fulcrum-point whereby a movement of the rod in one direction shifts the position of the lever to elongate one spring and shorten the other and vice versa.

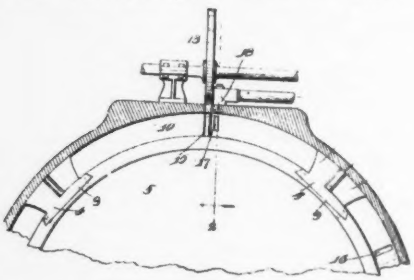
803,746. AIR-BRAKE RELEASE AND SIGNAL VALVE. Frank H. Dukesmith, Meadville, Pa. Filed May 6, 1905. Serial No. 259,182.

803,815. AIR-BRAKE SYSTEM. Frank H. Dukesmith, Meadville, Pa. Filed May 6, 1905. Serial No. 259,180.

803,943. FLUID-PRESSURE BRAKE. Martin F. Volkmann, Santa Monica, Cal. Filed Apr. 26, 1905. Serial No. 257,493.

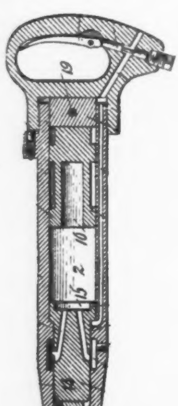
804,136. AIR-BRAKE MECHANISM. Richard W. Kelly, Los Angeles, Cal., assignor of one-fourth to Henry T. Hazard and one-fourth to George E. Harpham, Los Angeles, Cal. Filed Sept. 3, 1904. Serial No. 223,287.

804,027. AIR-COMPRESSOR. Christian Neumann, St. Louis, Mo., assignor to Natural Power Company, St. Louis, Mo., a Corporation. Filed Dec. 8, 1904. Serial No. 236,050.



An air-compressor, comprising a casing forming a compression-chamber, a revolving disk therein, pistons having forward and rearward tapered ends located upon the said disk; a rotary cut-off disk traveling through the compressing-chamber and having openings for the passage of the piston whereof to compress air between the pistons and disk, substantially as specified.

804,449. PNEUMATIC TOOL. Edward B. Boyer, Peoria, Ill. Filed Aug. 13, 1904. Serial No. 220,687.



The combination of a cylinder, the imperforate piston arranged to reciprocate in one end of said cylinder, the hammer-piston arranged to reciprocate in the other end of said cylinder, means for supplying motive fluid to the said cylinder between said pistons to cause them to move in opposite directions, the hammer-piston to deliver a blow and the imperforate piston to compress the air in the cylinder behind it, the said compressed air serving to cause the forward movement to said piston, the exhaust duct for permitting the escape of motive fluid from the cylinder and means for supplying motive fluid in front of said hammer-piston to drive it rearwardly.

804,088. PNEUMATIC TIRE. Manley H. Blakeslee, Buffalo, N. Y., assignor of one-half to Roscoe D. Baker, Buffalo, N. Y. Filed Dec. 1, 1904. Serial No. 235,068.

804,368. RESILIENT TIRE. William F. Beasley, Plymouth, N. C. Filed Dec. 15, 1902. Renewed Jan. 9, 1904. Serial No. 188,405.

804,437. SYSTEM OF TUNNELING. James W. See, Hamilton, Ohio. Filed June 30, 1905. Serial No. 267,727.

The improved method of tunneling consisting in constructing a subtunnel below and continuous to the proposed main tunnel; constructing a branch from the subtunnel; constructing an upcut leading from said branch to a point in or contiguous to the line of the proposed main tunnel; and constructing the main tunnel by the aid of said upcut, said branch, and said subtunnel.

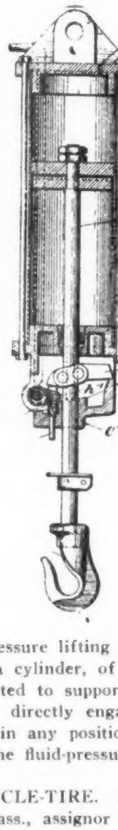
804,686. CHUCK OF ROCK-DRILLING MACHINES. John H. Thomas, Johannesburg, Transvaal. Filed Nov. 14, 1904. Serial No. 232,654.

In chucks of rock-drills or rock-drilling machines and means for fixing the bits or boring-tools therein, in combination, the chuck-body constructed with an axial bore, a longitudinal slot formed in the bore, a longitudinal recess formed inside the chuck in communication with the bore, a bit or drill-shank constructed with a lateral projection adapted to be brought into engagement with the longitudinal recess inside the bore by the axial rotation of the drill or bit, a keyway or tapered slot formed through the chuck passing down one side of the longitudinal recess, and a tapered key or wedge arranged in said keyway engaging the shank and lateral projection of the bit or tool to maintain the projection in engagement with the recess, substantially as described.

804,701. PNEUMATIC TIRE. Olin M. Bigger, Holt, Cal. Filed June 5, 1905. Serial No. 263,735.

804,745. ELECTRICALLY-CONTROLLED FLUID-PRESSURE RAILWAY-BRAKE. John S. Lockwood, Kansas City, Mo. Filed Feb. 5, 1904. Renewed Mar. 24, 1905. Serial No. 251,846.

804,510. PNEUMATIC HOIST. Henry H. Vaughan, Cleveland, Ohio, assignor to Ridgely and Johnson Tool Company, a Corporation of Illinois. Filed Nov. 19, 1902. Serial No. 131,947.



In a fluid-pressure lifting apparatus, the combination with a cylinder, of a piston therein, a piston-rod adapted to support a load, automatic mechanism for directly engaging and retaining the piston-rod in any position to which it may be moved by the fluid-pressure.

804,772. VEHICLE-TIRE. Franklin G. Saylor, Franklin, Mass., assignor to M. and S. Tire Company, Boston, Mass., a Corporation of Massachusetts. Filed Mar. 28, 1903. Renewed Apr. 11, 1905. Serial No. 255,009.

804,888. PNEUMATIC GIN-FEEDER. John W. Seifert, Prattville, Ala. Filed Aug. 9, 1904. Serial No. 220,130.

804,896. VEHICLE TIRE AND RIM. Will C. State, Akron, Ohio, assignor to The Goodyear Tire and Rubber Company, Akron, Ohio, a Corporation of Ohio. Filed June 26, 1905. Serial No. 267,133.

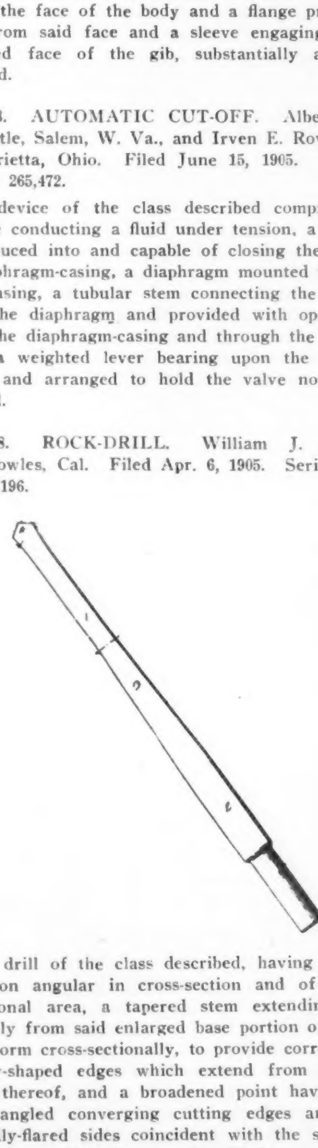
804,904. CHUCK FOR ROCK-DRILLS. James C. H. Vaught, Deadwood, S. D. Filed Oct. 31, 1904. Serial No. 230,803.

A drill-chuck, comprising a body having a longitudinal socket, to receive the shank, and a longitudinal slot, a gib in the slot adopted to bear at its inner face on the shank and having a longitudinally-tapered outer face projecting beyond the face of the body and a flange projecting from said face and a sleeve engaging said tapered face of the gib, substantially as described.

804,978. AUTOMATIC CUT-OFF. Albert D. Purtle, Salem, W. Va., and Irven E. Rowland, Marietta, Ohio. Filed June 15, 1905. Serial No. 265,472.

A device of the class described comprising, a pipe conducting a fluid under tension, a valve introduced into and capable of closing the pipe, a diaphragm-casing, a diaphragm mounted within the casing, a tubular stem connecting the valve and the diaphragm and provided with openings into the diaphragm-casing and through the valve, and a weighted lever bearing upon the valve-stem and arranged to hold the valve normally closed.

805,008. ROCK-DRILL. William J. Ertle, Knowles, Cal. Filed Apr. 6, 1905. Serial No. 254,196.



A drill of the class described, having a base portion angular in cross-section and of larger sectional area, a tapered stem extending outwardly from said enlarged base portion of angular form cross-sectionally, to provide correspondingly-shaped edges which extend from end to end thereof, and a broadened point having obtuse-angled converging cutting edges and outwardly-flared sides coincident with the sides of the stem, substantially as described.

805,054. GLASS-WORKING APPARATUS. Irving W. Colburn, Franklin, Pa. Filed Oct. 1, 1905. Serial No. 176,375.

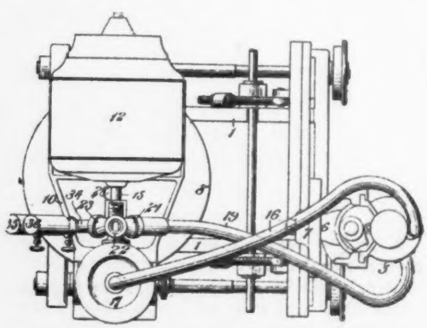
In a glass-drawing apparatus, the combination of glass-drawing devices, a melting or refining chamber, a receiving chamber or pot, a delivery-chamber intermediate the refining and receiving chambers, means supplying compressed air to the upper part of the delivery-chamber, and a valve controlling the flow of molten glass from the melting-chamber to the delivery-chamber.

805,055. GLASS-DRAWING APPARATUS. Irving W. Colburn, Franklin, Pa. Filed Apr. 22, 1904. Serial No. 204,435.

In glass-drawing apparatus, the combination of a receptacle containing molten glass, means for drawing a cylinder therefrom, a conduit leading to the interior of said cylinder while it is being drawn, and means supplying a gradually-increasing fluid-pressure to the said conduit during the drawing operation.

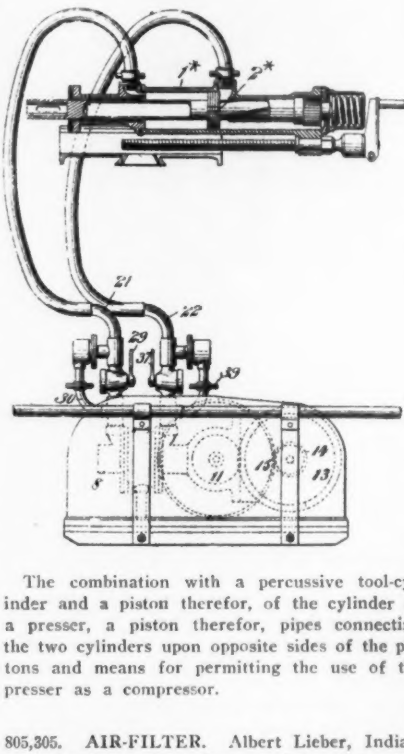
805,168. PNEUMATIC-DESPATCH APPARATUS. Charles F. Stoddard, Boston, Mass., assignor to American Pneumatic Service Company, Dover, Del., a Corporation of Delaware. Filed May 13, 1904. Renewed Mar. 28, 1905. Serial No. 252,528.

805,195. ELECTRO-PNEUMATIC CHANNELER. Arthur H. Gibson, Easton, Pa., assignor to The Ingersoll-Sergeant Drill Company, New York, N. Y., a Corporation of West Virginia. Filed Apr. 27, 1905. Serial No. 257,737.



In combination, a truck, a channeler adjustably mounted thereon and a presser adjustably mounted on the truck whereby the channeler and presser cylinders may be kept in close proximity to each other as the channeler is adjusted to different positions along the truck.

805,196. FLUID-PRESSER. Arthur H. Gibson, Easton, Pa., assignor to The Ingersoll-Sergeant Drill Company, New York, N. Y., a Corporation of West Virginia. Filed Apr. 27, 1905. Serial No. 257,738.



The combination with a percussive tool-cylinder and a piston therefor, of the cylinder of a presser, a piston therefor, pipes connecting the two cylinders upon opposite sides of the pistons and means for permitting the use of the presser as a compressor.

805,305. AIR-FILTER. Albert Lieber, Indianapolis, Ind. Filed Nov. 9, 1904. Serial No. 232,045.

An air-filter including a casing, an air-inlet pipe leading into one end of the casing, an air-outlet pipe leading from the other end thereof, a series of perforated partitional disks located within the casing at intervals between the inlet and outlet pipes, filtering material between said disks, and means for charging the incoming air with chemicals, substantially as set forth.

805,306. AIR-FILTER. Albert Lieber, Indianapolis, Ind. Filed Dec. 5, 1904. Serial No. 235,552.

805,347. PNEUMATIC PIANO-PLAYER. Edward N. Dickerson, Stovall, N. C. Filed Dec. 17, 1902. Serial No. 135,554.

805,356. PNEUMATIC MALTING-DRUM. Franklin B. Giesler, Milwaukee, Wis. Filed Feb. 10, 1902. Serial No. 93,297.

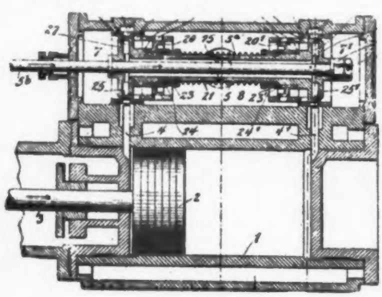
A rotary malting-drum having a coupling connecting its sprinkling-pipes, a closed-end hollow conical spigot loose in the coupling and provided with a water-outlet, a water-conductor pipe coupled to the spigot, a sleeve having water-tight connection with said coupling, a stuffing box in the sleeve engaged by the water-conductor pipe, the latter being provided with a leak-port within said sleeve, and means for circulating air in the drum.

805,396. GAS-PRESSURE REGULATOR. John W. Weeks, Providence, R. I. Filed May 19, 1905. Serial No. 261,114.

An automatic pressure-regulator comprising a casing having an inlet provided with a valve-seat, and an outlet, a swinging member pivotally supported in the bottom of said casing adjacent said valve-seat, toggle members connected to said swinging member, a valve pivoted to the free end of said swinging member, and having a wiping contact with said valve-seat, a gasometer fitting over the top of said casing, and a connecting member extending from said toggle members to said gasometer.

805,399. POWER-CONTROLLING DEVICE. Herbert H. Williams, New York, N. Y. Filed Jan. 20, 1902. Serial No. 90,440.

805,630. AIR-PUMP. Theodore N. Case, Mount Vernon, N. Y. Filed May 13, 1904. Serial No. 207,751.



In an air-pump the combination of a pump-cylinder, a valve-chamber connected therewith by ports at each end of said cylinder, a main valve in said chamber having corresponding ports disconnected from one another and having an equalizing-passage formed entirely within the body of the valve and independent of the suction and discharge passages and adapted to connect the two ends of said cylinder, separate auxiliary valves for independently controlling said main valve-ports, said auxiliary valves being carried by said main valve, a discharge-passage leading from the discharge sides of said auxiliary valves and a suction-passage leading to the suction side of said main valve.

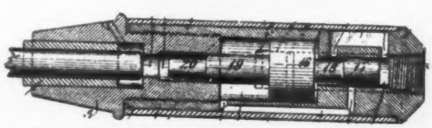
805,420. MECHANISM FOR AUTOMATICALLY ACTUATING AIR-BRAKES. Claus P. Geritz, Kingsland, N. J. Filed Nov. 25, 1904. Serial No. 234,230.

805,458. LIQUID-AGITATOR. Adam Good, Claflin, Kans. Filed Oct. 27, 1904. Serial No. 230,271.

805,474. MEANS FOR INFLATING RUBBER TIRES. Alfonso G. Lavertine and James E. McNellan, Johannesburg, Transvaal. Filed Mar. 6, 1905. Serial No. 248,632.

805,865. AIR-BRUSH. Oscar Liberman, Pittsburg, Pa. Filed June 10, 1905. Serial No. 264,721.

805,633. PNEUMATIC TOOL. John F. Clement, Philadelphia, Pa. Filed Jan. 24, 1905. Serial No. 242,523.

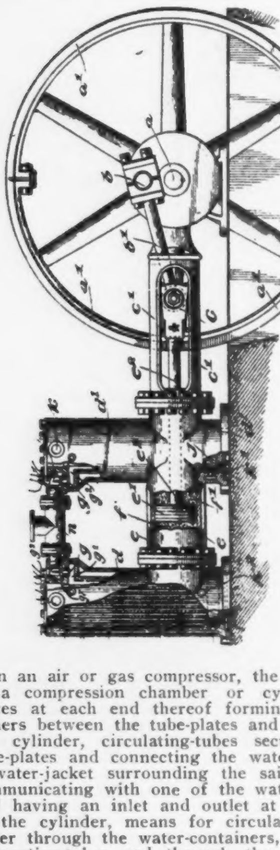


In a pneumatic tool, a casing, a piston therein, said piston having an enlarged head, a smaller head at the rear of said enlarged head, a neck adjacent to said smaller head and of less diameter than said smaller head, said neck controlling the admission of motive fluid to the piston to force the same forwardly, said smaller head always having constant pressure thereon and controlling the admission of motive fluid to return the piston, and said enlarged head controlling the exhaust of the motive fluid.

805,997. PNEUMATIC STACKER. Owen Puterbaugh, Laura, Ohio. Filed Apr. 18, 1905. Serial No. 256,208.

806,026. IGNITING MECHANISM FOR AIR-TORPEDOES, &c. Wilhelm T. Unge, Stockholm, Sweden. Filed Oct. 2, 1903. Serial No. 175,486.

805,843. AIR OR GAS COMPRESSOR. Henry L. Doherty, Madison, Wis. Filed Feb. 27, 1904. Serial No. 195,529.



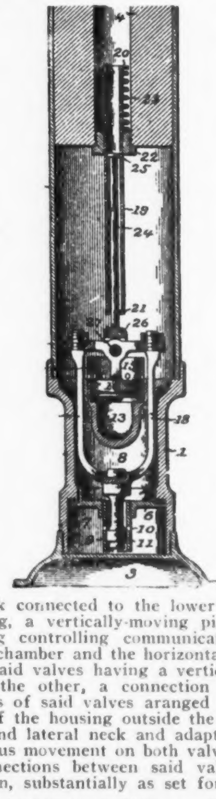
In an air or gas compressor, the combination of a compression chamber or cylinder, tube-plates at each end thereof forming water-containers between the tube-plates and the ends of the cylinder, circulating-tubes secured in the tube-plates and connecting the water-containers, a water-jacket surrounding the said tubes and communicating with one of the water-containers and having an inlet and outlet at the exterior of the cylinder, means for circulating cooling-water through the water-containers, through the connecting-tubes and through the water-jacket, inlet and outlet valves connected with the remaining portion of the space in the cylinder around and between the tubes, and means for forcing an air or gas compressing medium into said space around and between the tubes.

806,035. ELECTRIC SIGNALING AND ELECTROPNEUMATIC TRAIN-CONTROL SYSTEM. John A. Whyte, Toronto, Canada. Filed Sept. 2, 1904. Serial No. 223,160.

806,088. JACK FOR RELIEVING PRESSURE ON PNEUMATIC TIRES OF MOTOR VEHICLES. John C. Wands, St. Louis, Mo. Filed May 18, 1905. Serial No. 260,995.

805,860. HYDRAULIC AIR-PUMP. George J. Keenan, Chicago, Ill. Filed Oct. 10, 1904. Serial No. 227,824.

In a hydraulic air-pump of the character herein described, the combination of a vertical cylinder, a weighted piston arranged therein, a valve-housing at the lower end of said cylinder, a partition in said housing dividing the same into upper and lower chambers, a vertical valve-casing in said partition connecting said chambers together, a vertically-moving piston-valve in said casing controlling such connection, a vertical valve-casing in the upper chamber aforesaid, a lateral hori-



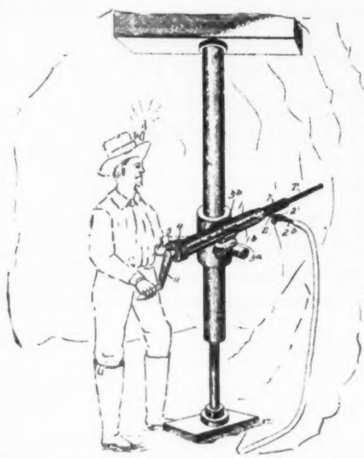
zontal neck connected to the lower end of said valve-casing, a vertically-moving piston-valve in said casing controlling communication between the upper chamber and the horizontal neck aforesaid, the said valves having a vertical alinement one with the other, a connection between the upper ends of said valves aranged in the upper chamber of the housing outside the upper valve-chamber and lateral neck and adapted to impose simultaneous movement on both valves, and operative connections between said valves and the pump-piston, substantially as set forth.

805,885. MINING-MACHINE. William H. Sexton, Sullivan, Ind. Filed July 6, 1905. Serial No. 268,362.

In a mining-machine the combination of the bed-frame, a carriage slidably mounted in the frame and comprising side bars connected at the front by a cross-bar comprising upper and lower plates, guide-wheels journaled between the ends of the plates, a drive-wheel journaled at the rear of the carriage, a cutter-chain supported on the drive-wheel, and the guide-wheels, and means for supporting the cutter-chain between the guide-wheels comprising shafts of relatively large diameter engaging counterbored openings in the plates and provided with a longitudinal opening and with radial openings communicating therewith, bolts reversing the shafts and the plates, nuts engaging the bolts for securing the shafts and plates together and rollers on the shafts.

806,012. ROCK-DRILL. Grant W. Smith, Ottumwa, Iowa. Filed Nov. 21, 1904. Renewed Oct. 19, 1905. Serial No. 283,499.

A rock-drilling mechanism comprising a fixedly-held casing and a pneumatic hammer longitudinally adjustable within said casing and telescopically arranged with respect to the casing,



means for adjusting said hammer within said casing, means for detachably securing the hammer and hammer-adjusting means within the casing, said hammer and said adjusting means being bodily removable from the casing.

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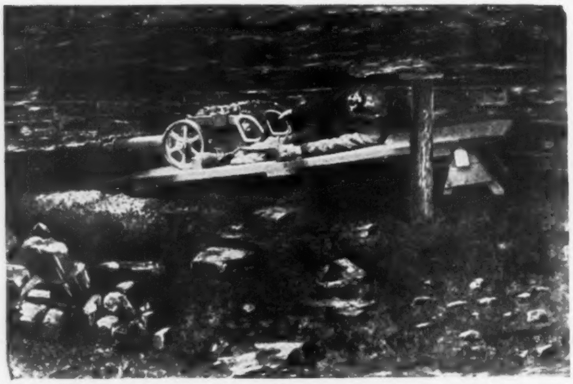

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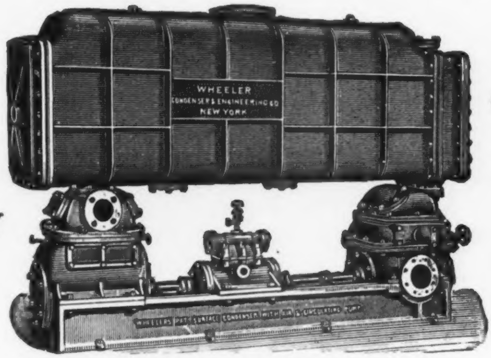

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